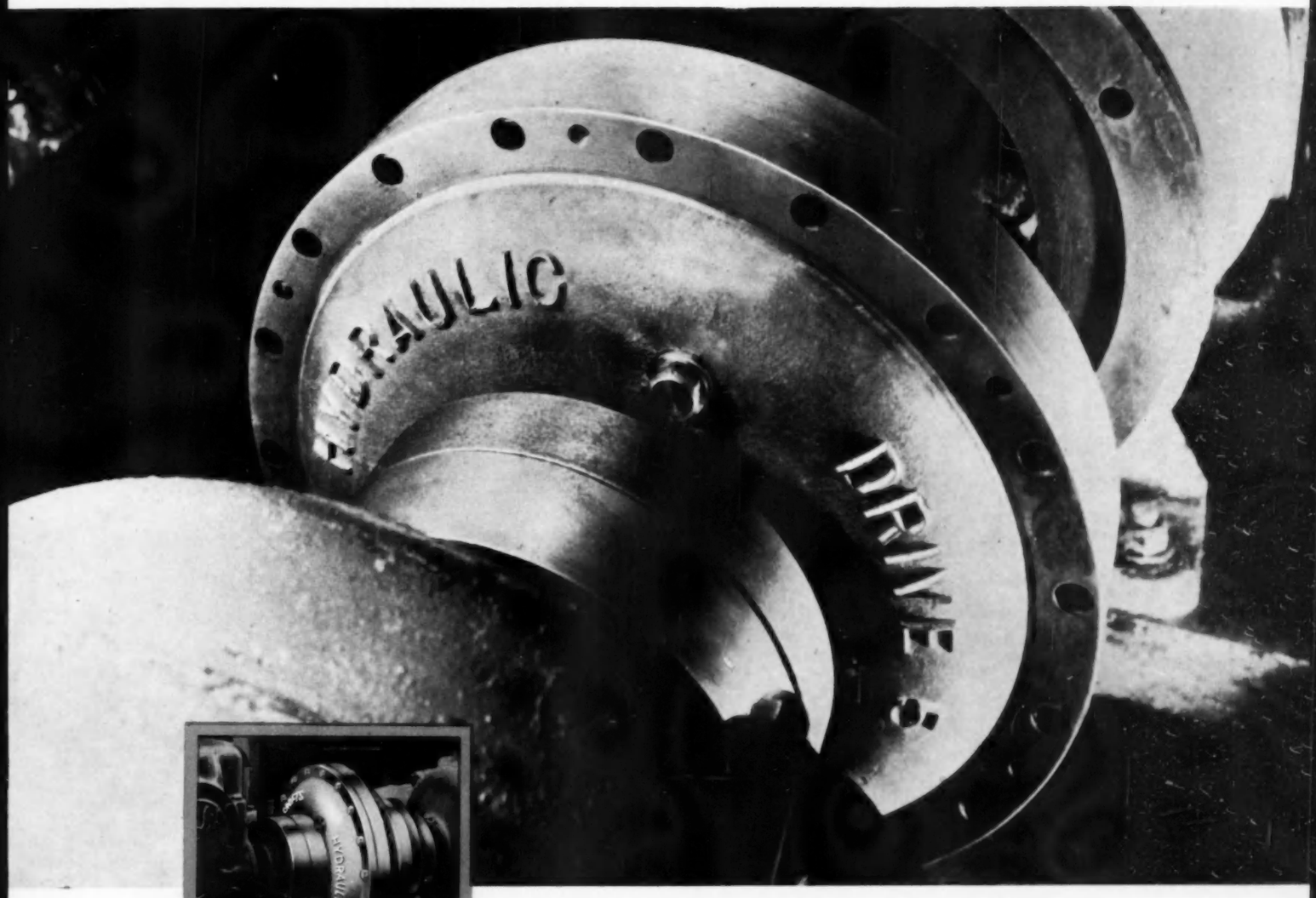
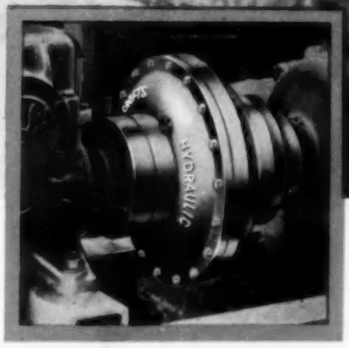
THE ENGINEER

NOVEMBER 18, 1960 | 28 ESSEX STREET, STRAND, LONDON, W.C.2 | TWO SHILLINGS





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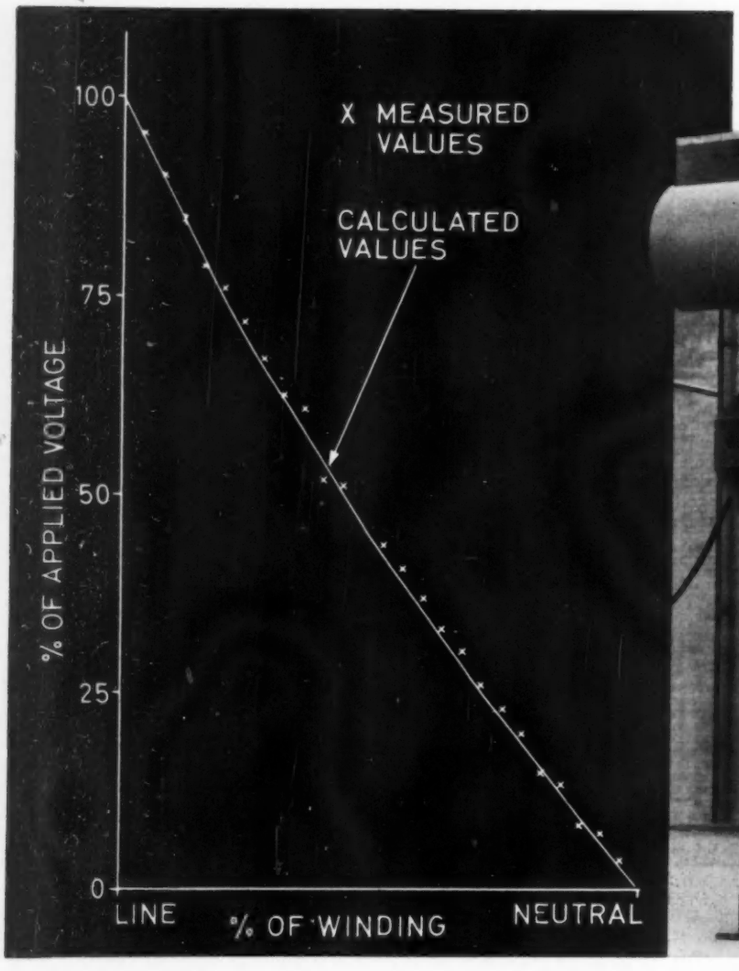

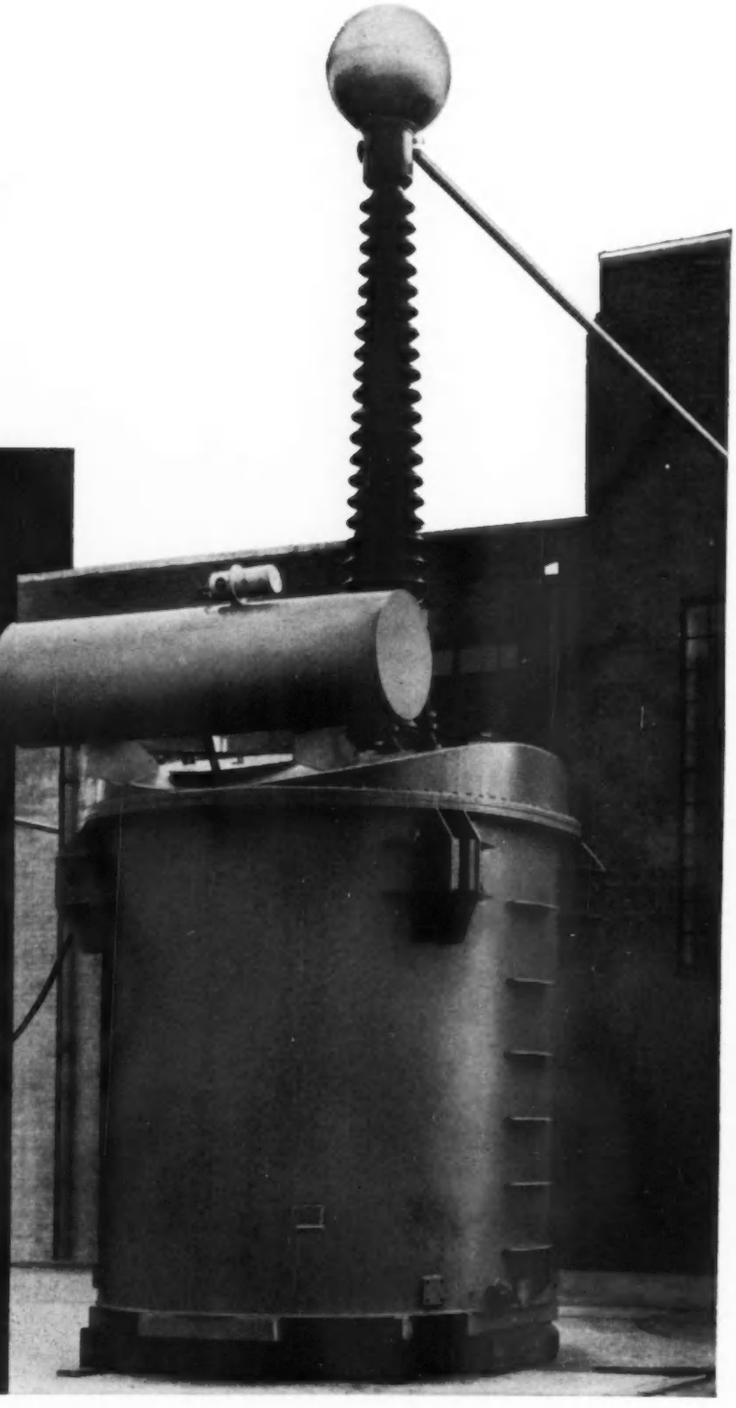

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THE ENGINEER

Established 1856

No. 5469 **NOVEMBER 18, 1960** VOL. 210

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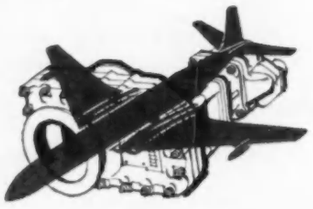

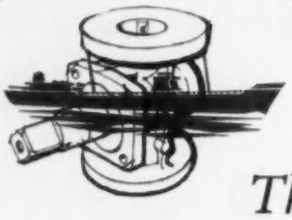

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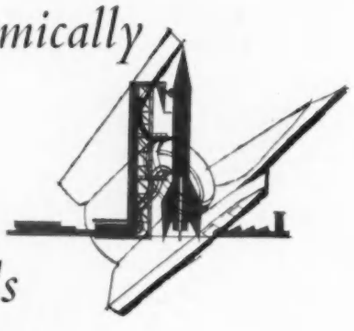

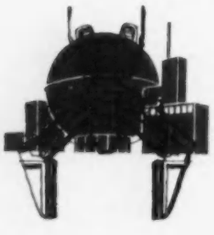

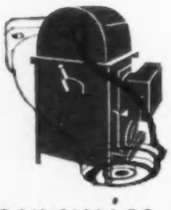

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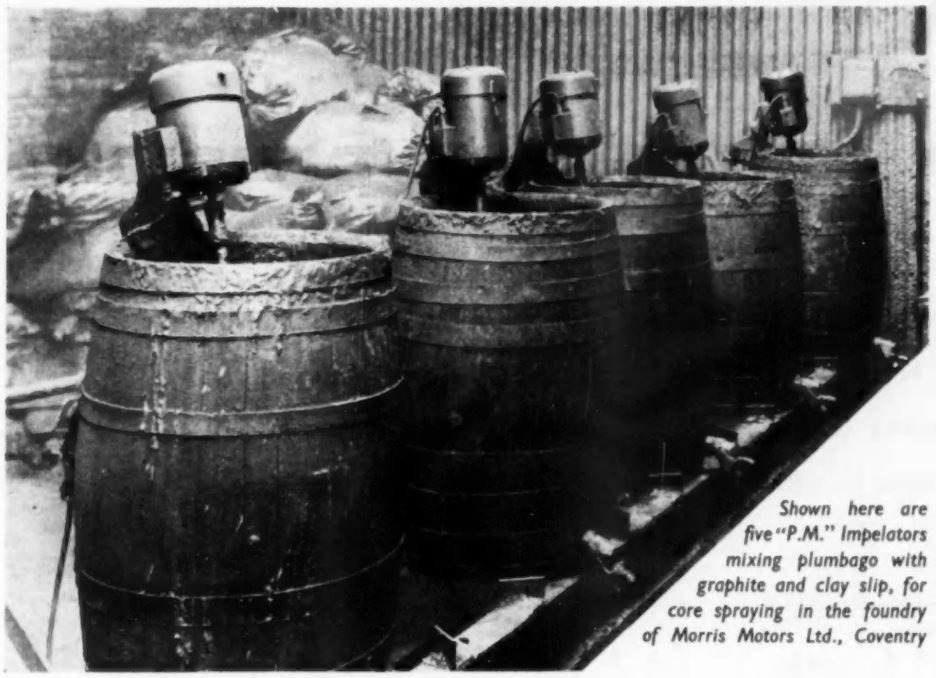

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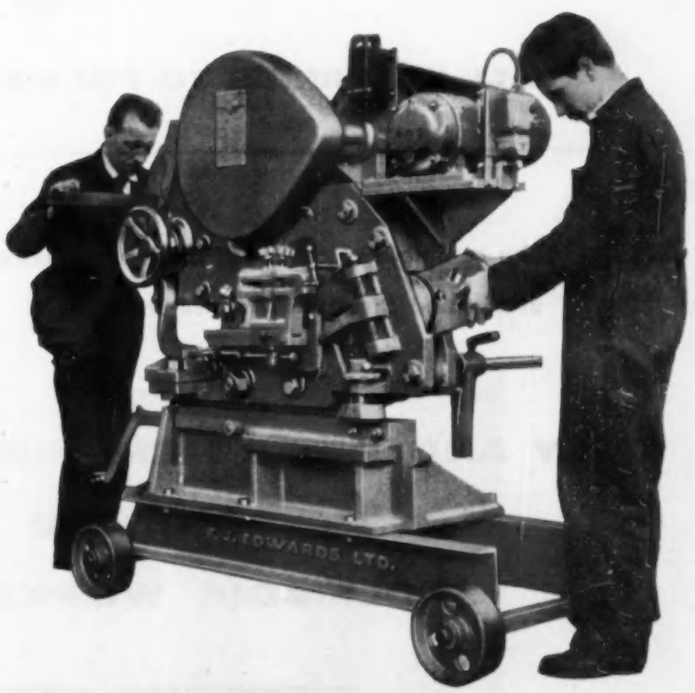

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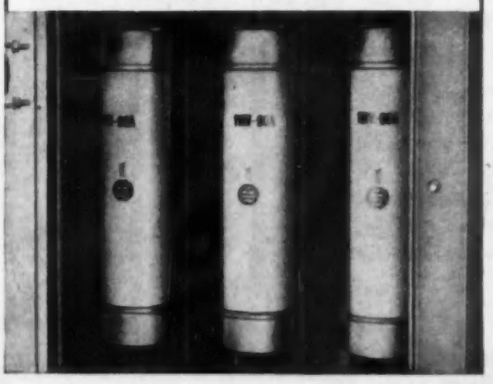

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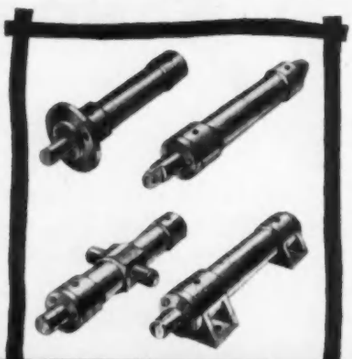

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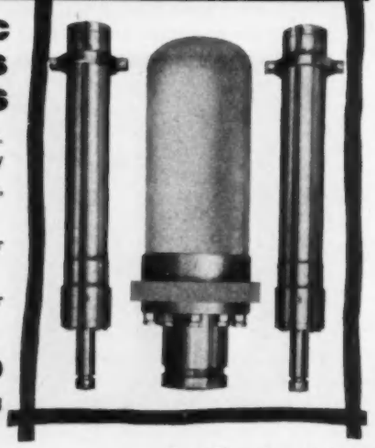

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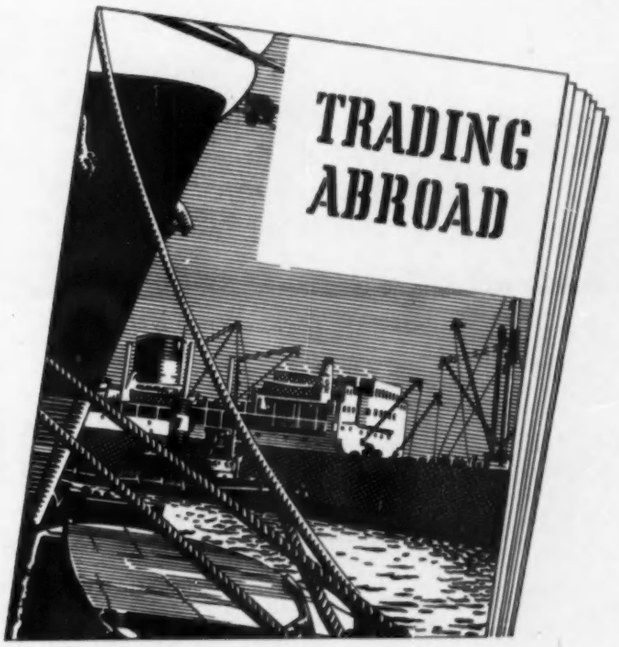

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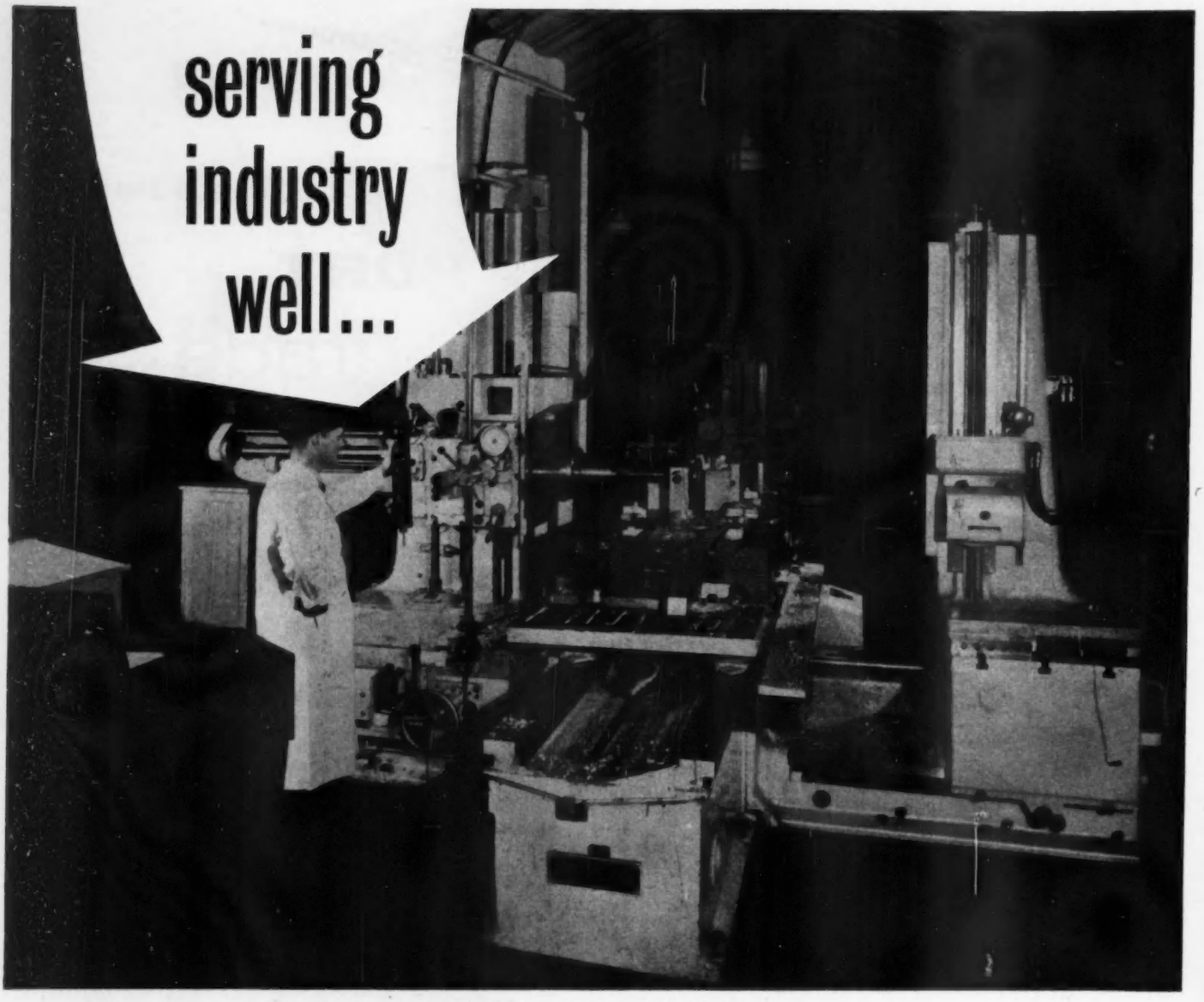

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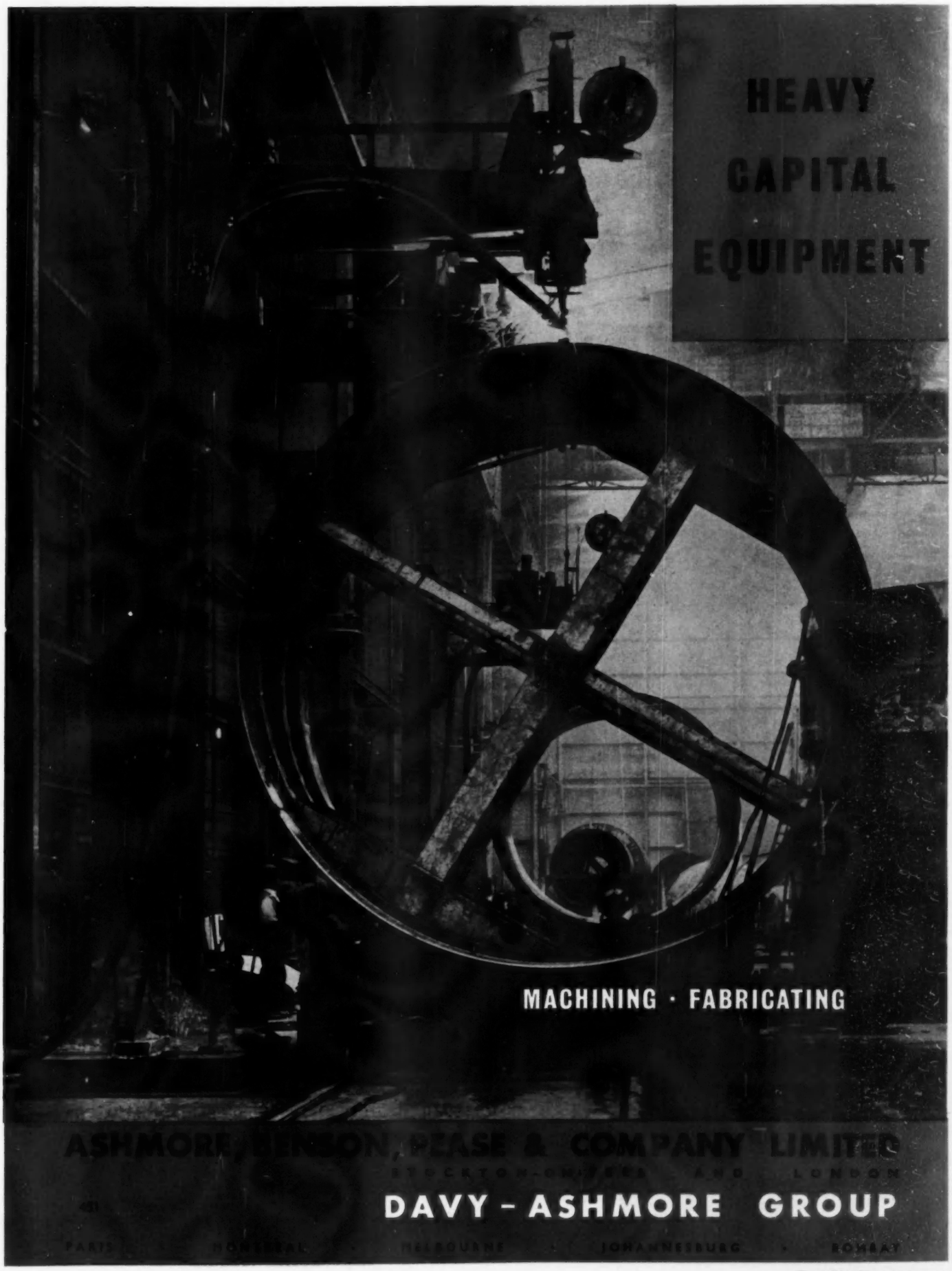

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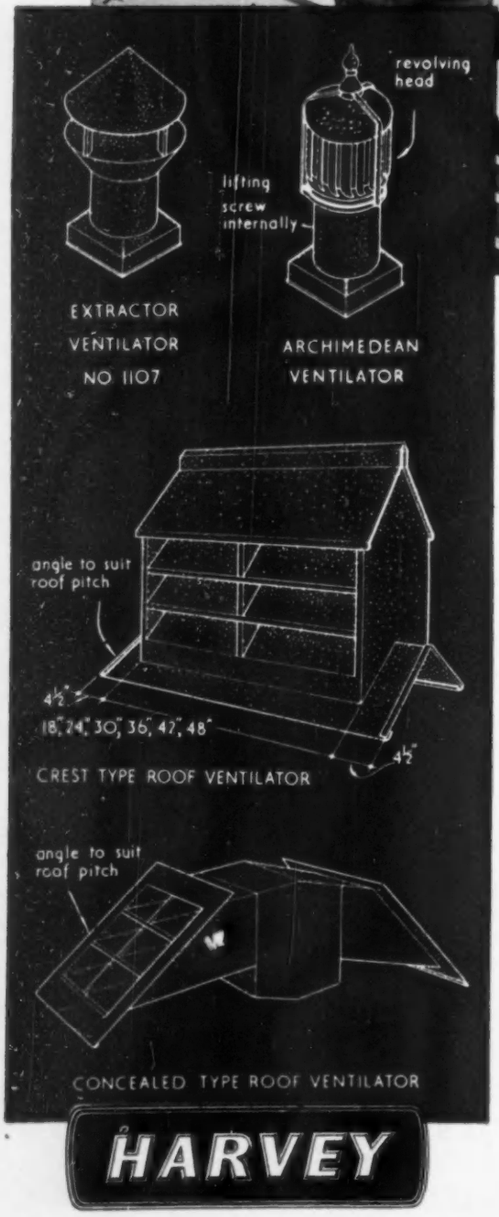

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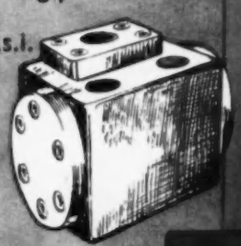

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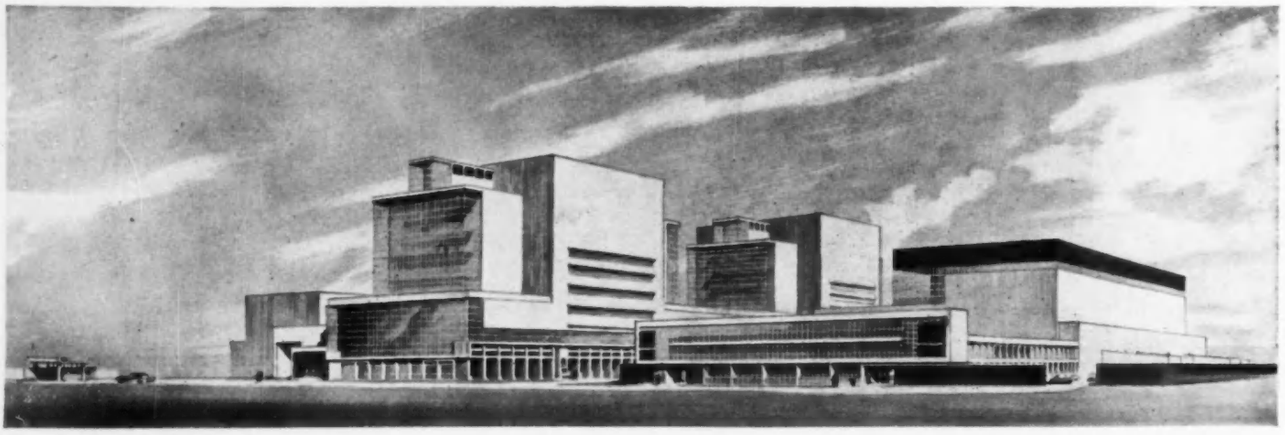

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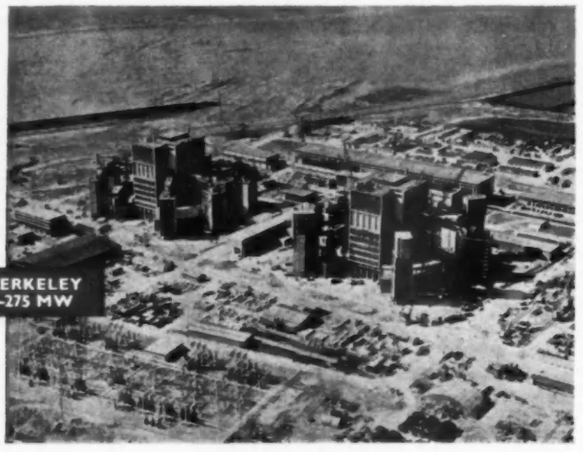

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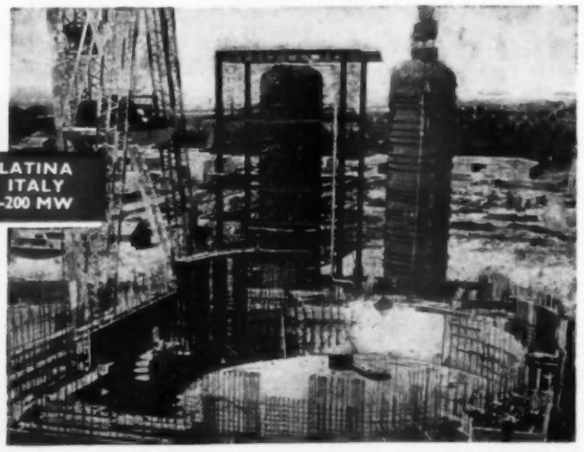

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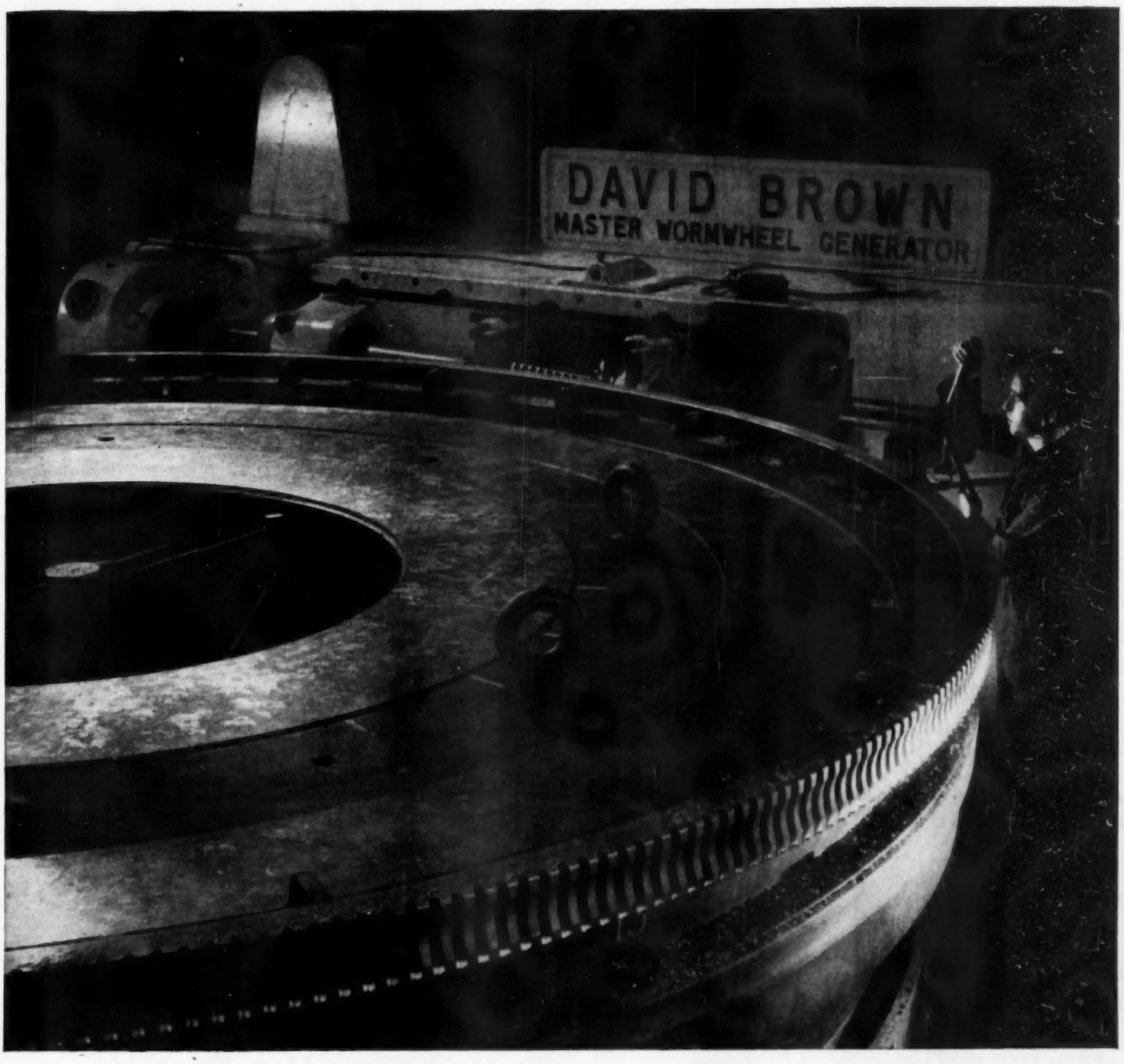

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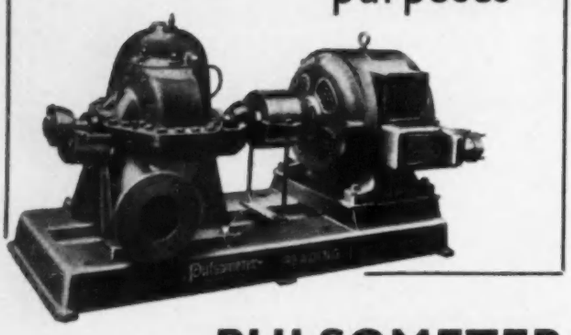
C

PUMPS
for all general purposes



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HS Centrifugal Pumps

Pulsometer horizontally split HS type centrifugal pumps provide a range for all general purposes, including waterworks, mine drainage, handling of screened sewage, hot water circulation, petrol or diesel fuel oil transfer duties, etc.

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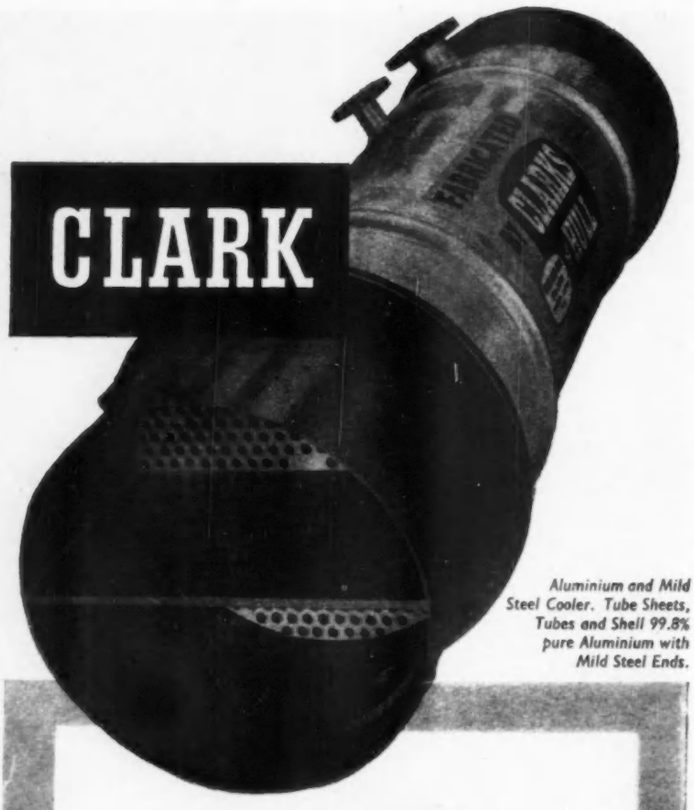

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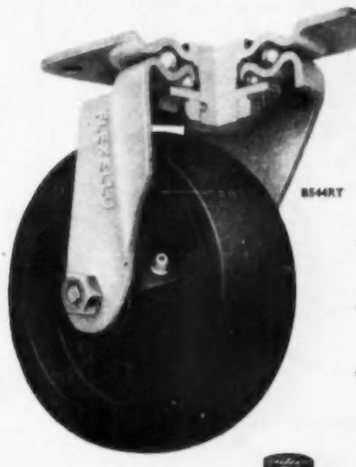

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- **Substantial kingpin adjustable for bearing protection.**
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Pipe socket fitting supplied with gas thread for outside fitting

Threaded stem and B.S. male pipe fitting

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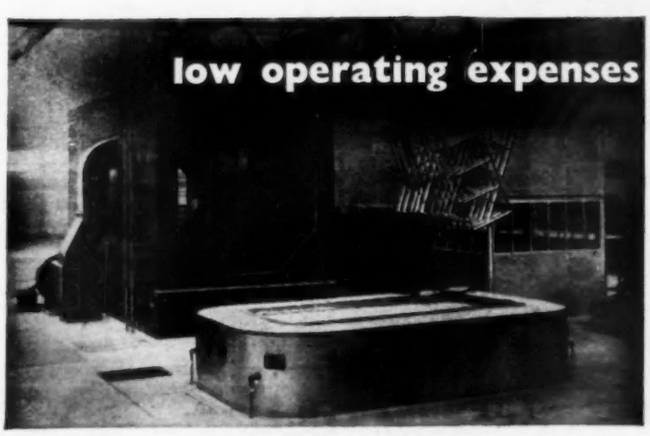

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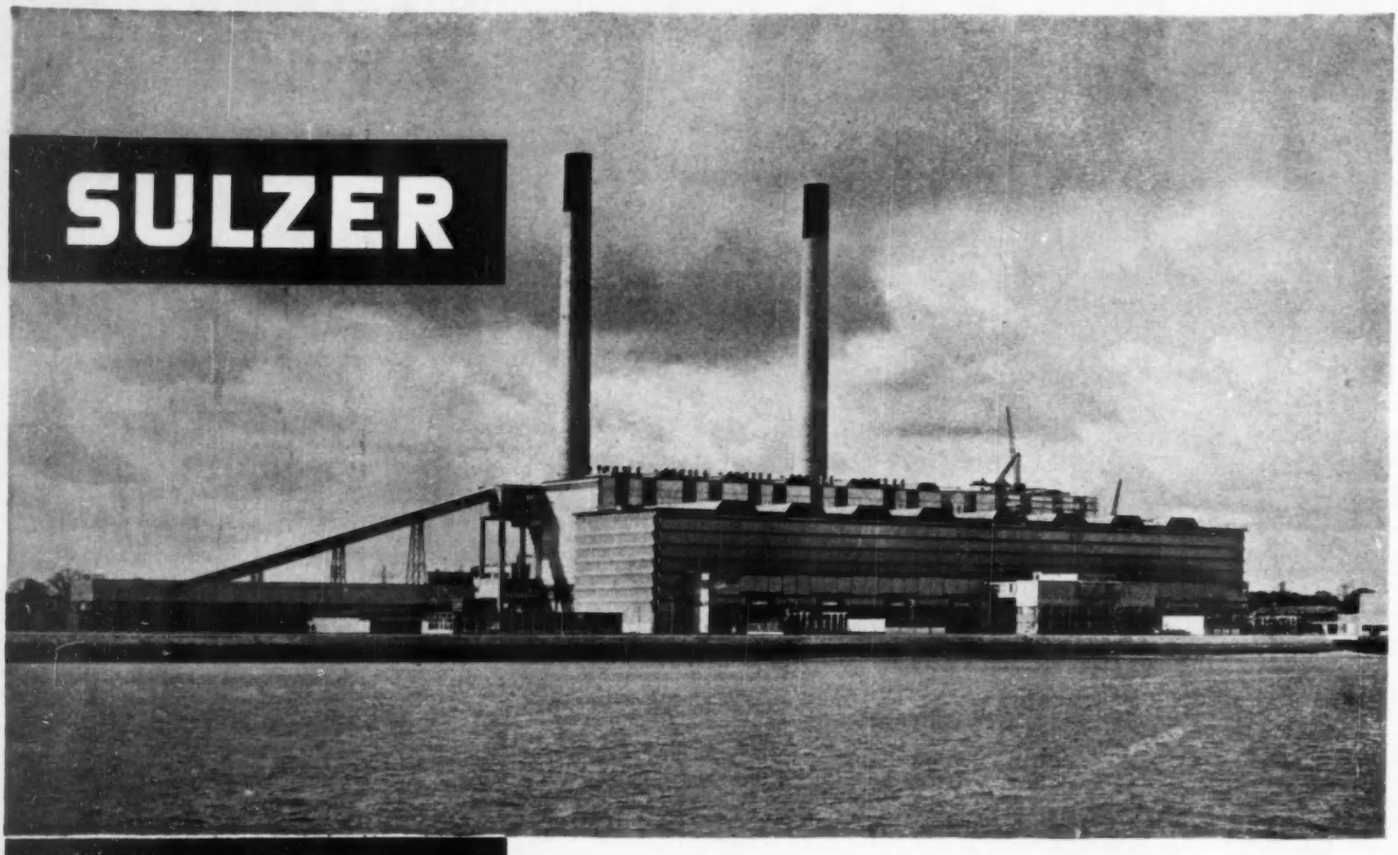

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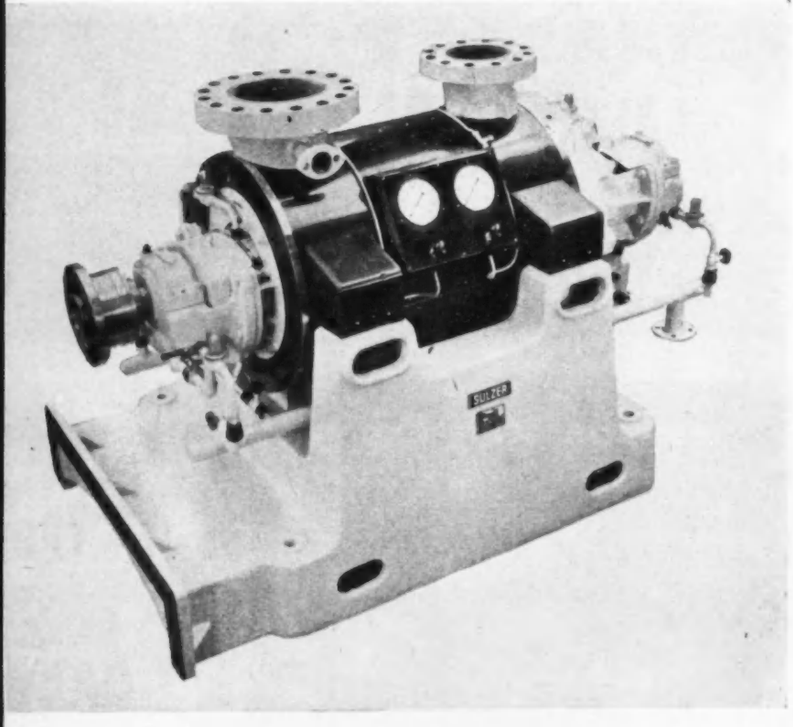

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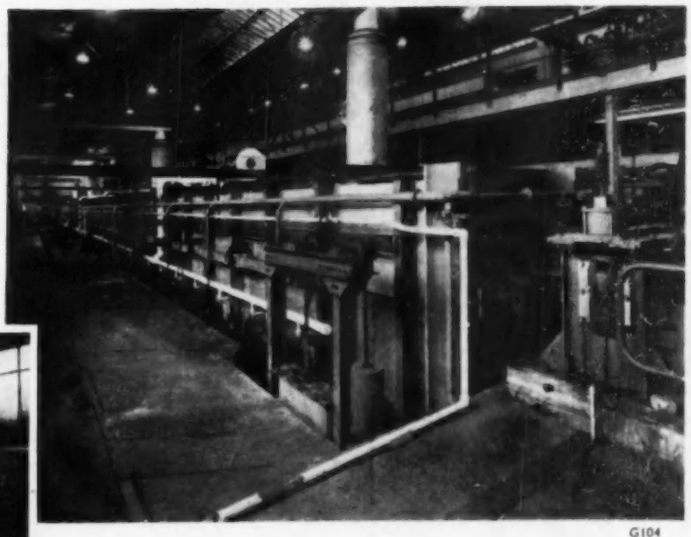
for continuous annealing of hot rolled silicon steel strip followed by rapid air cooling



G104

View of Air Cooling Section

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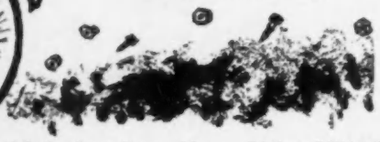

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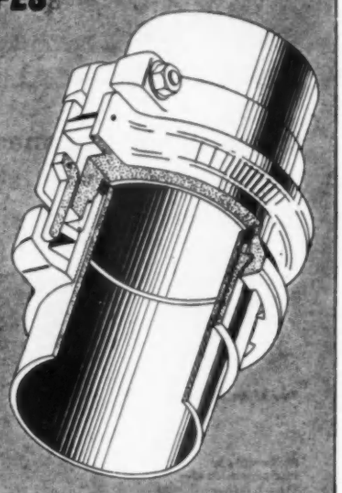

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No preparation is required for the ends of the pipes which may be Plain, Threaded, Grooved for other types of Couplings, or Bevelled for Welding, etc. The Coupling can be used on Bends, Tees or Crosses, and can be inserted into an existing pipeline without moving the pipes laterally. The WILSON-SEAMARK COUPLING has many and varied applications and has given the Engineer a new and useful pipe-laying tool. Please write for Wilson-Seamark Catalogue.

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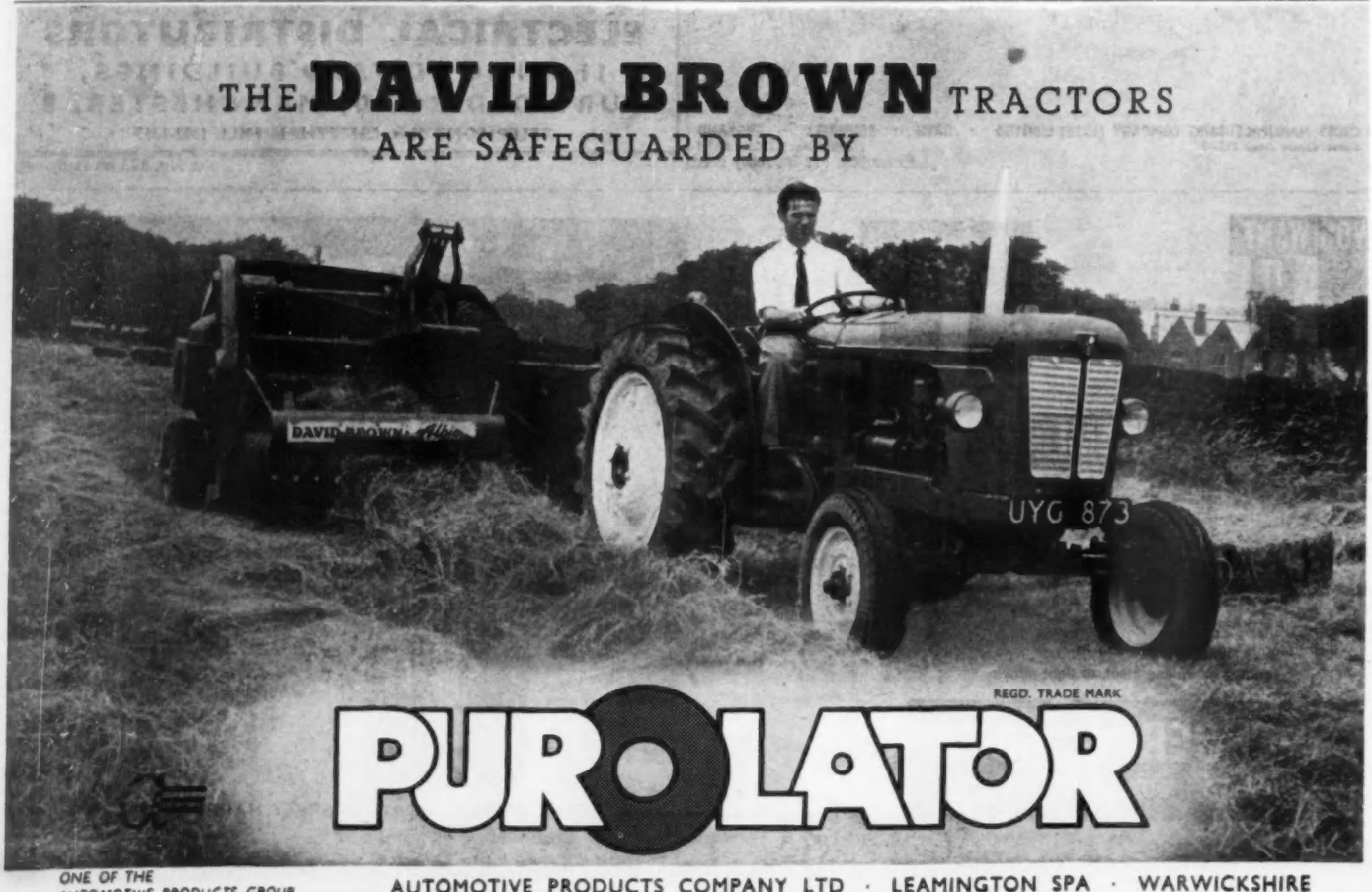

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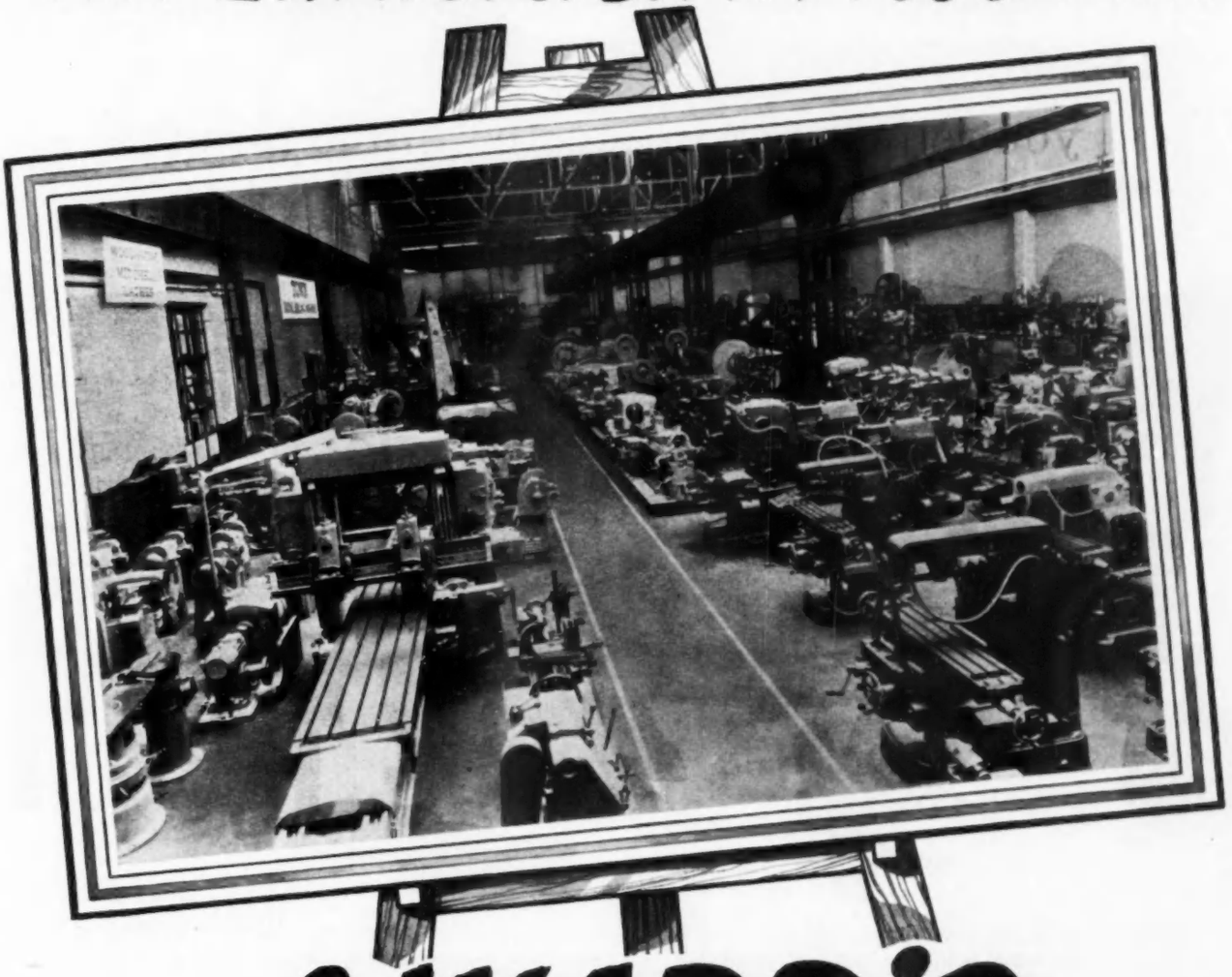

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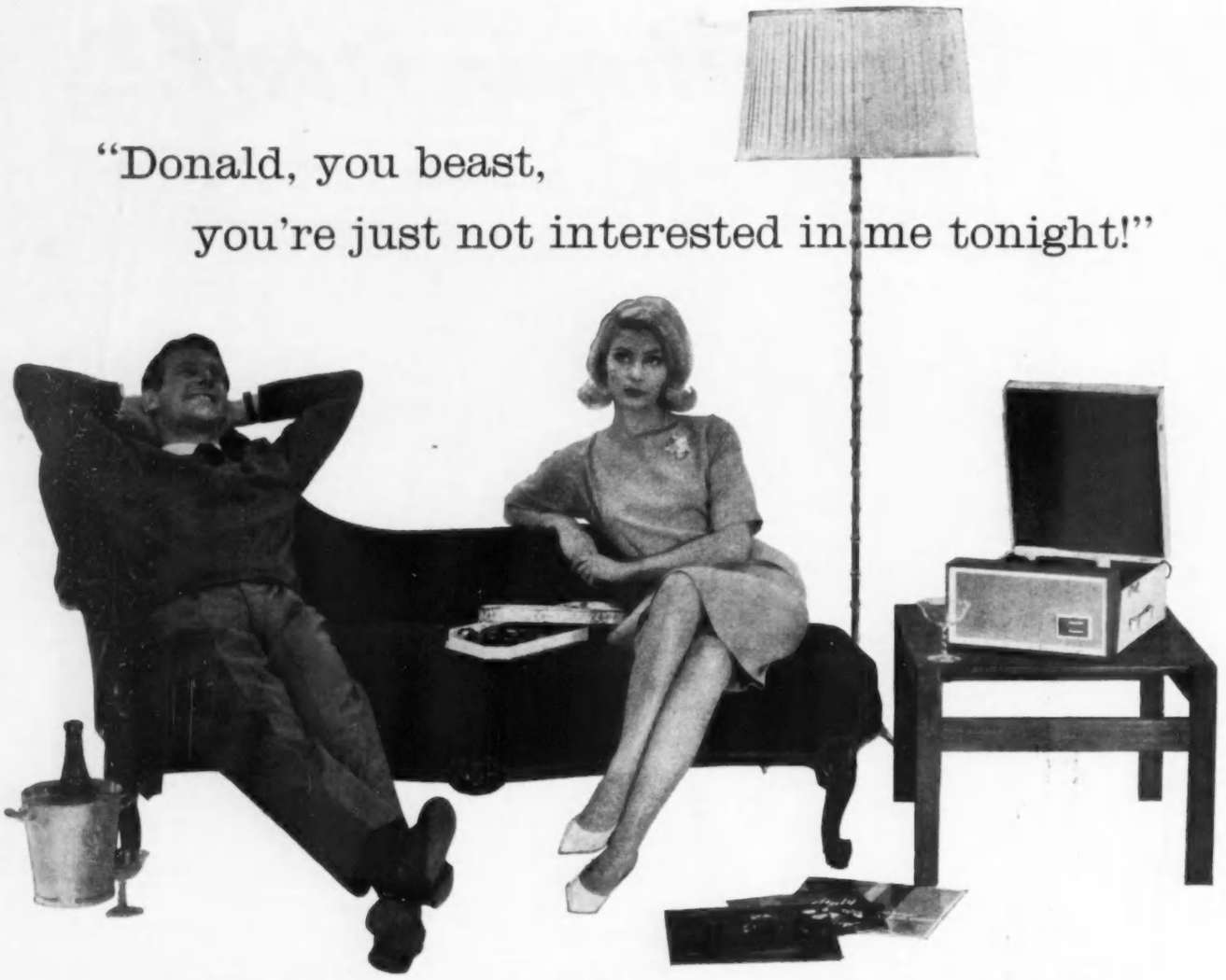
"Donald, you beast, you're just not interested in me tonight!"



"Sorry, Daphne, but something wonderful happened to-day. I discovered G.D. cone lock pipe-stoppers."

"Cone lock *whats*?"

"Pipe-stoppers, darling. Made by General Descaling. We've always needed something for bunging up open pipe-ends for pressure testing, and these tools are just the job . . . . . ."

"I'm sure you're terribly pleased . . . . . ."

". . . . . and they're *so* simple to use! Just pop one in the pipe—anything from 3" - 14" diameter—give the wing nut a couple of turns, and let the pressure do the rest. The bigger the squeeze, the tighter the stopper. It's the expanding vice ring that does it, you see. The lads are *mad* about G.D. cone locks!"

"That's nice for their girl-friends."

"They'll stand up to 2,000 lb. per square inch! And think of the other advantages—no more welding up bullplugs, blanks, connections or burning off afterwards. And they have a removable plug so we can fit pressure gauge connections. We can fit or remove them in a jiffy. They're re-usable, too—and that's *very* important when you're . . . . . ."

"I knew it. I should have invited Jim instead. He's in insurance!"

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General Descaling

the experts in pipeline and sewer maintenance

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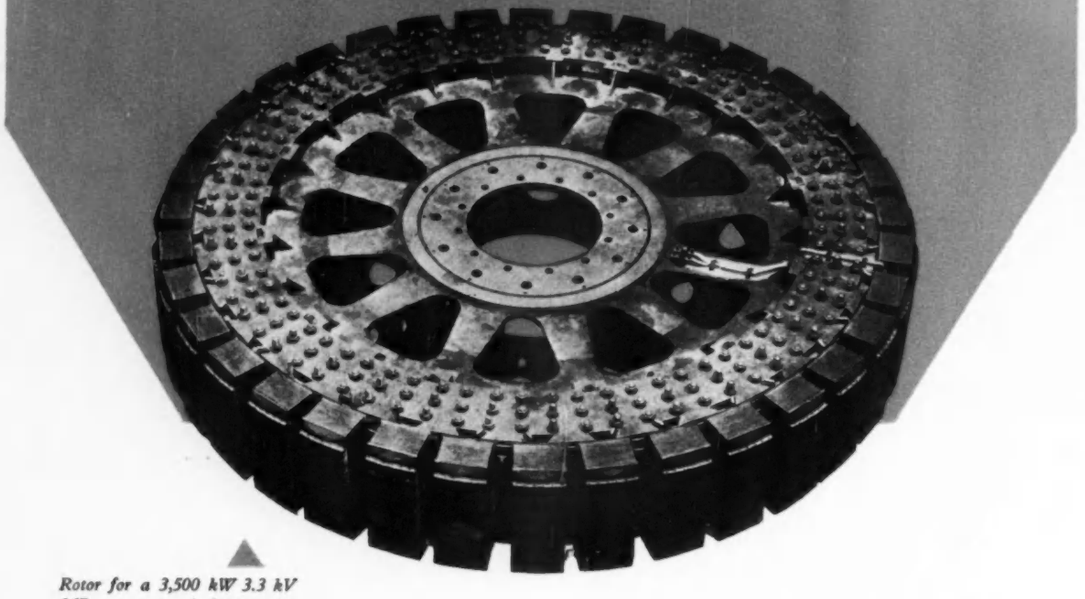
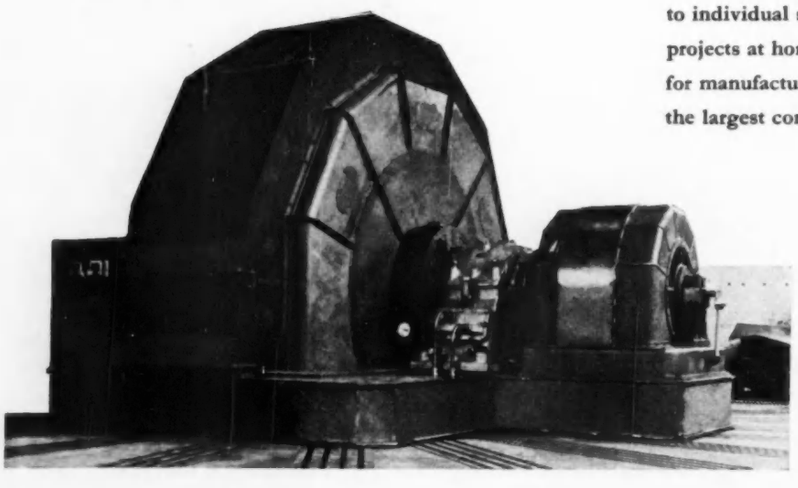


Rotor for a 3,500 kW 3.3 kV 167 r.p.m. vertical generator for the Lairg power station of the North of Scotland Hydro-Electric Board.

Bruce Peebles build generators, large or small, horizontal or vertical, designed to individual specifications, for hydro-electric projects at home and abroad. Ample resources for manufacture and testing enable the largest contracts to be undertaken.



One of two 12 MW 11 kV 375 r.p.m. horizontal generators for the Shin power station of the North of Scotland Hydro-Electric Board erected for test.

BRUCE PEEBLES & Co Limited ENGINEERS EDINBURGH

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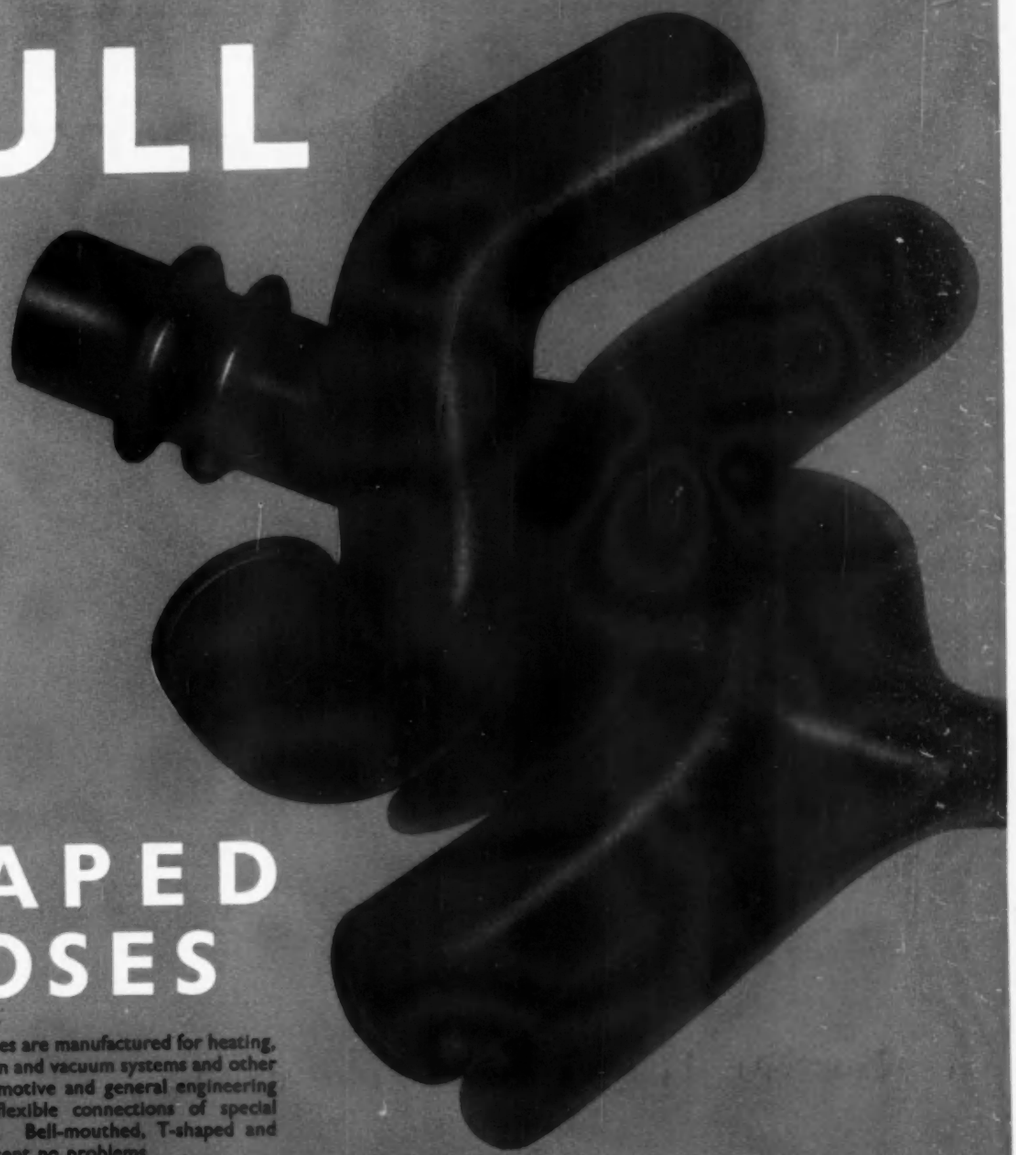

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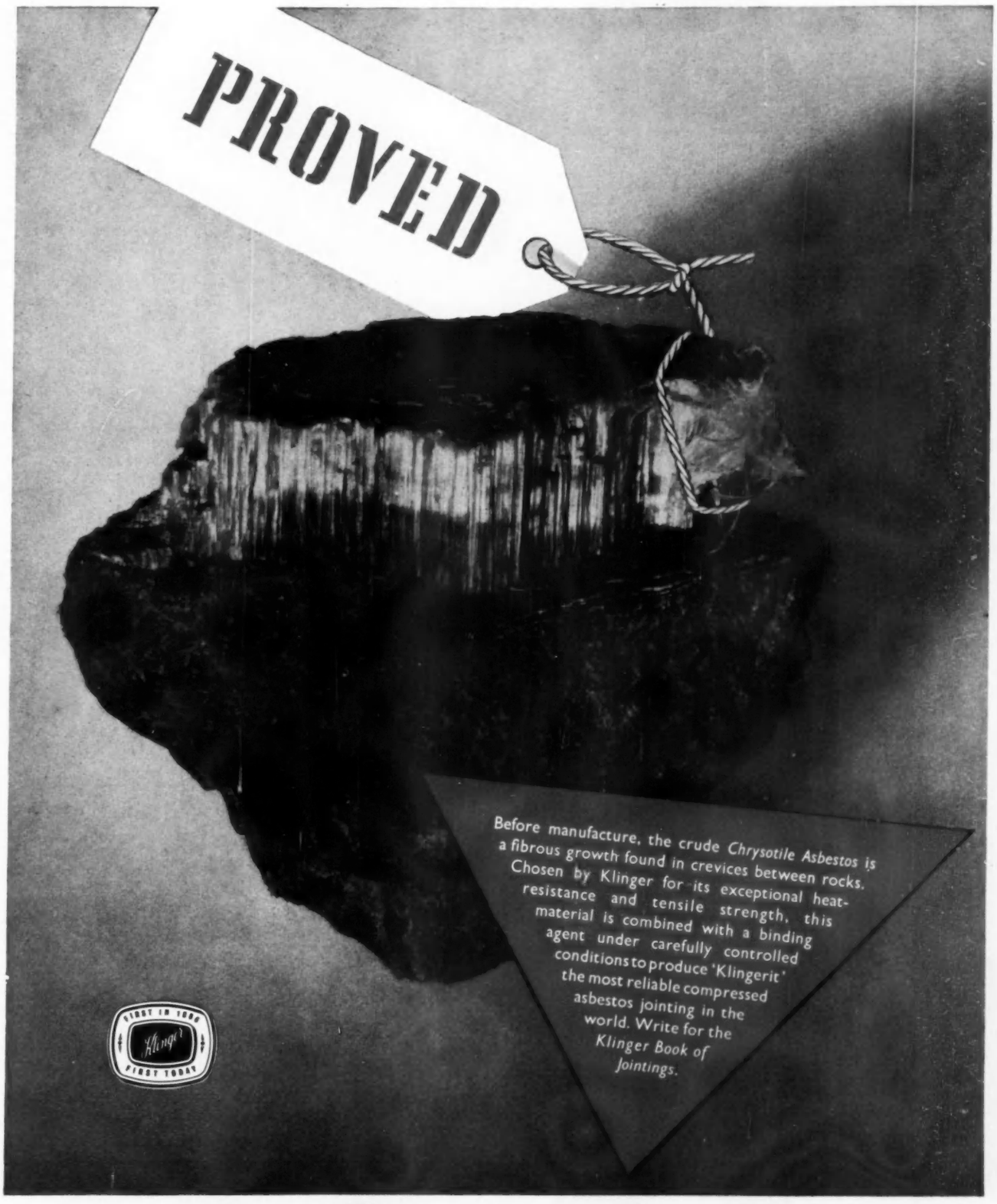
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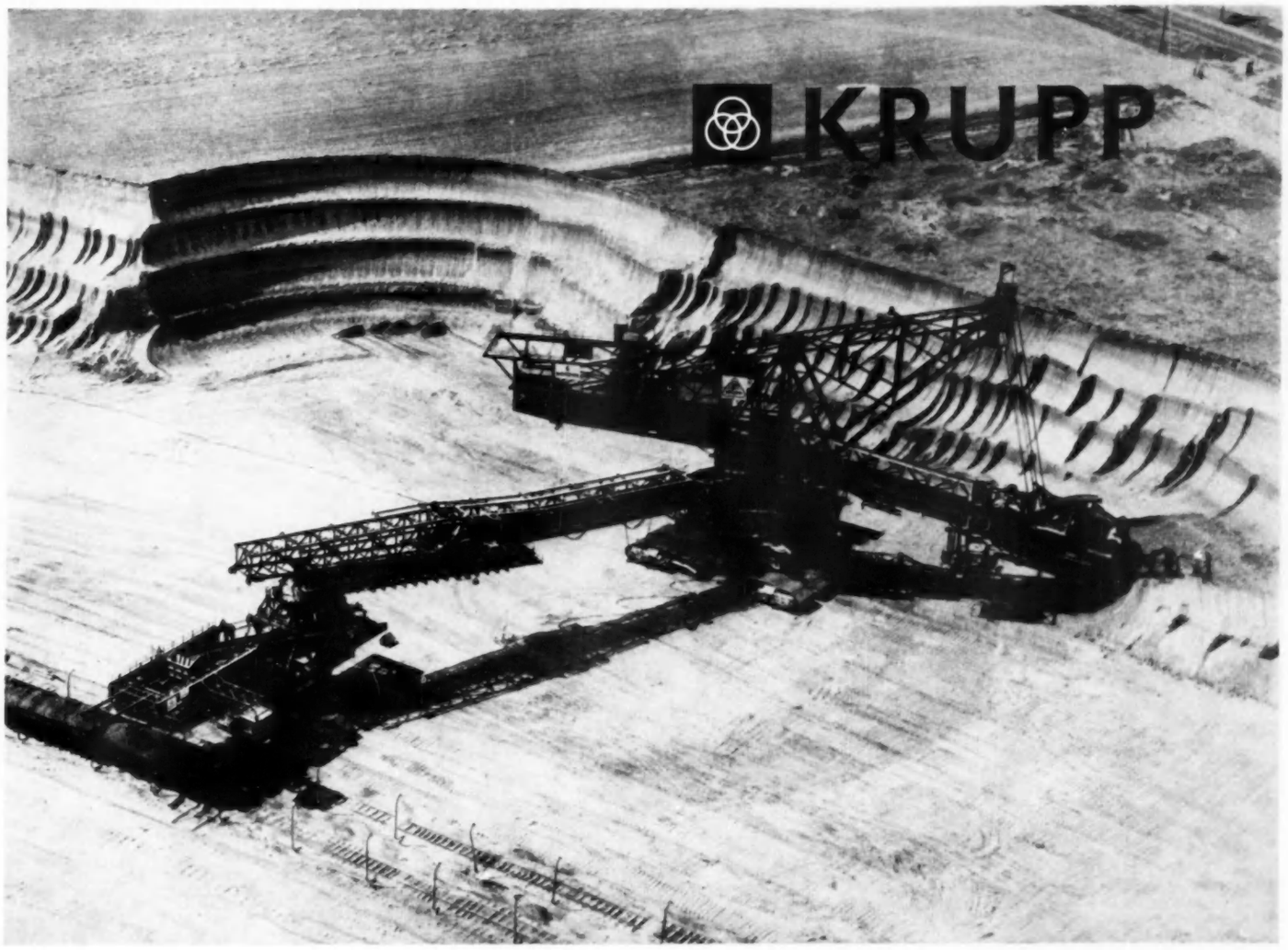

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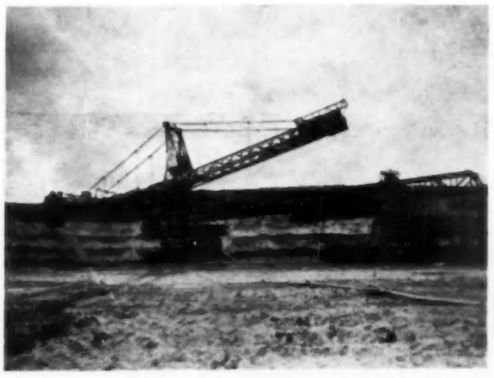

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with loading unit mounted on separate crawler tracks.

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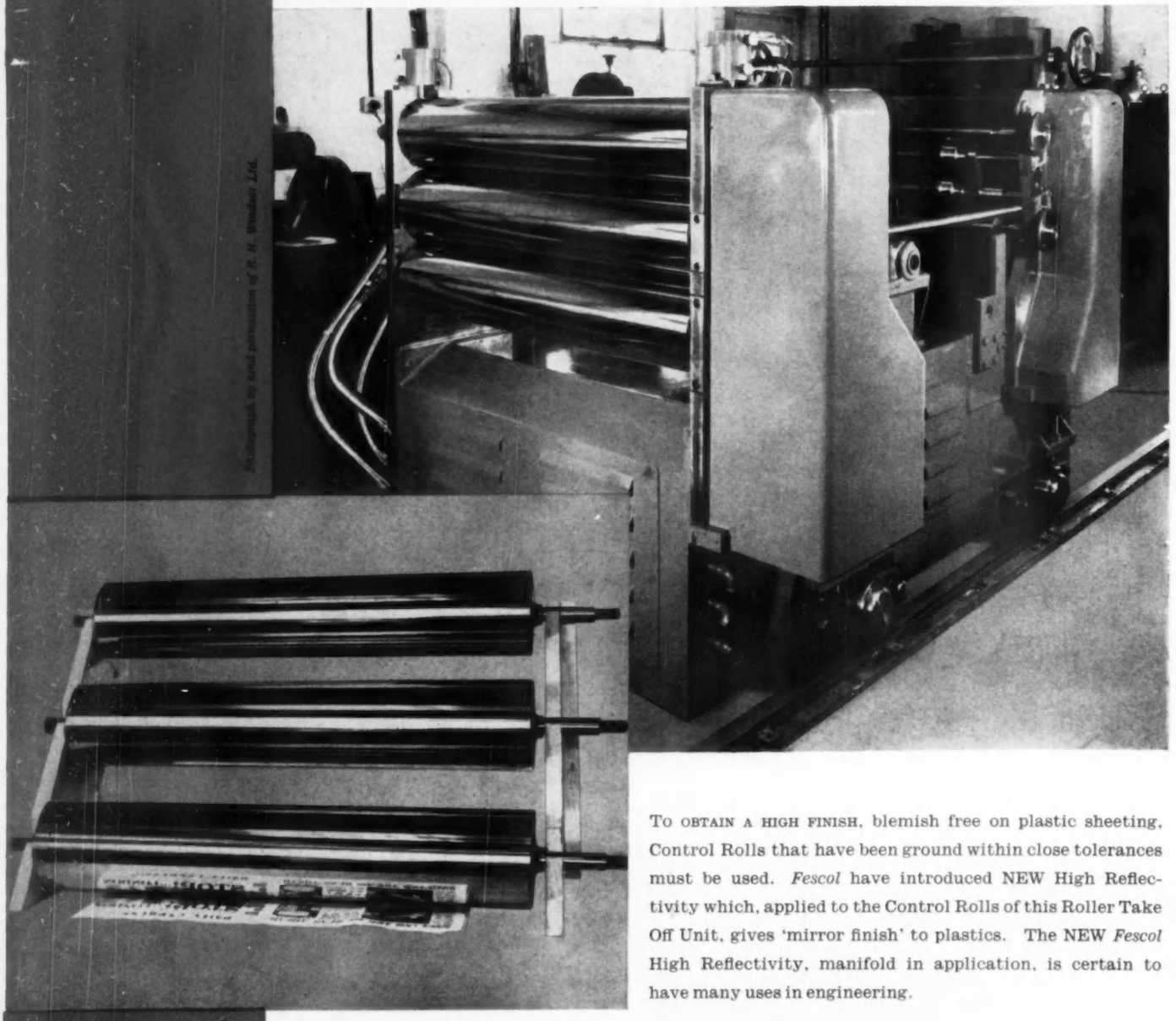
Upon reflection



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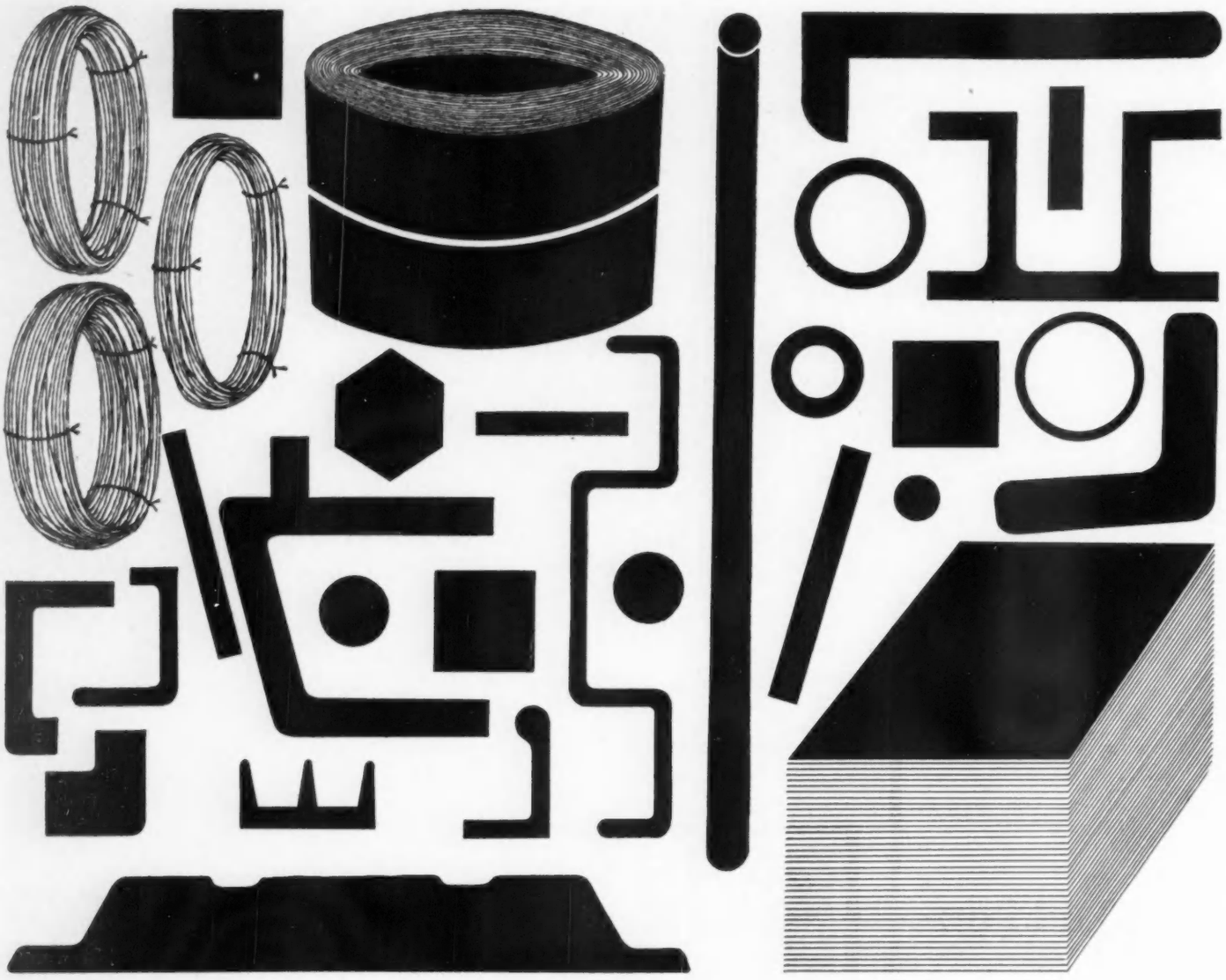

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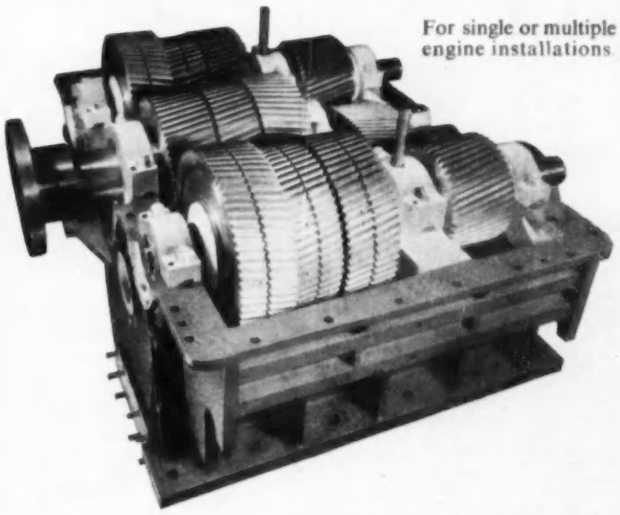

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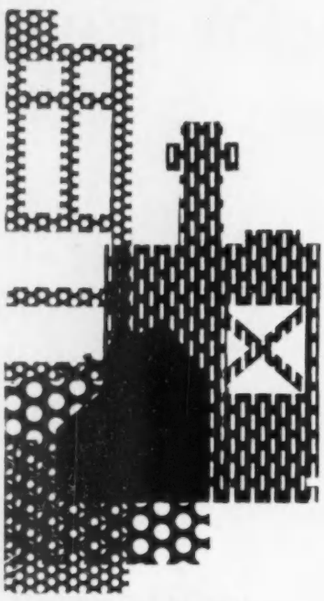

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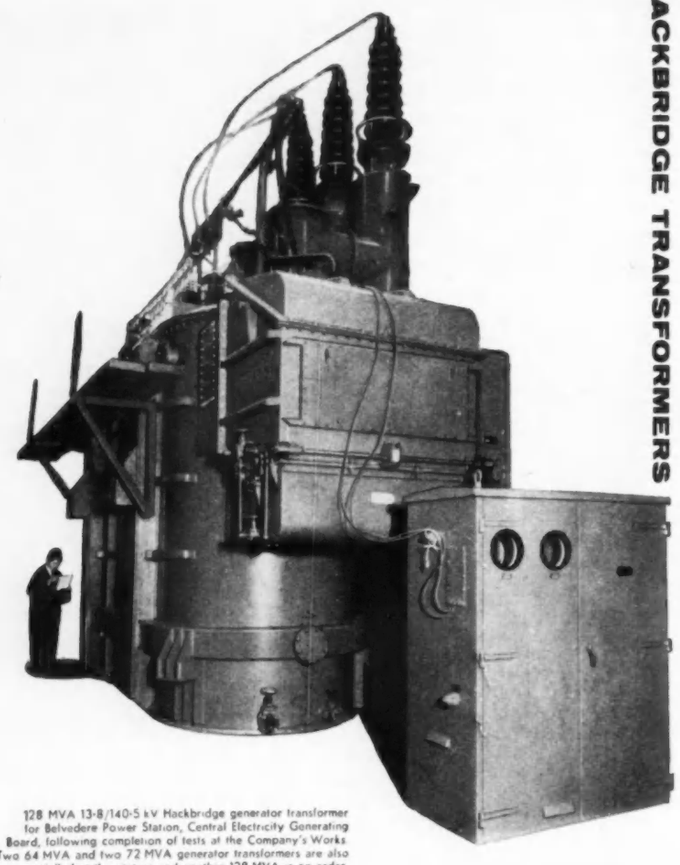

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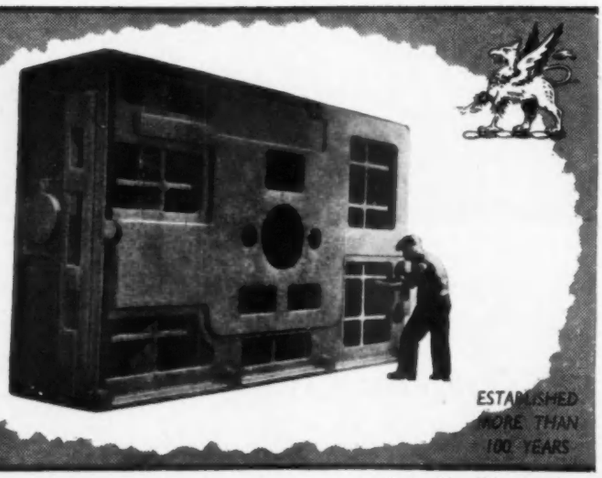

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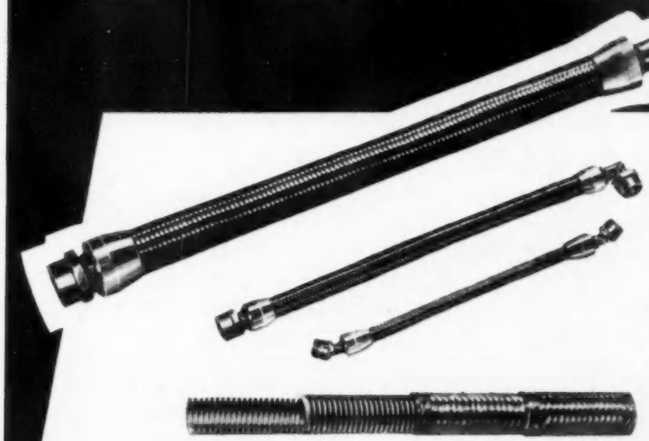

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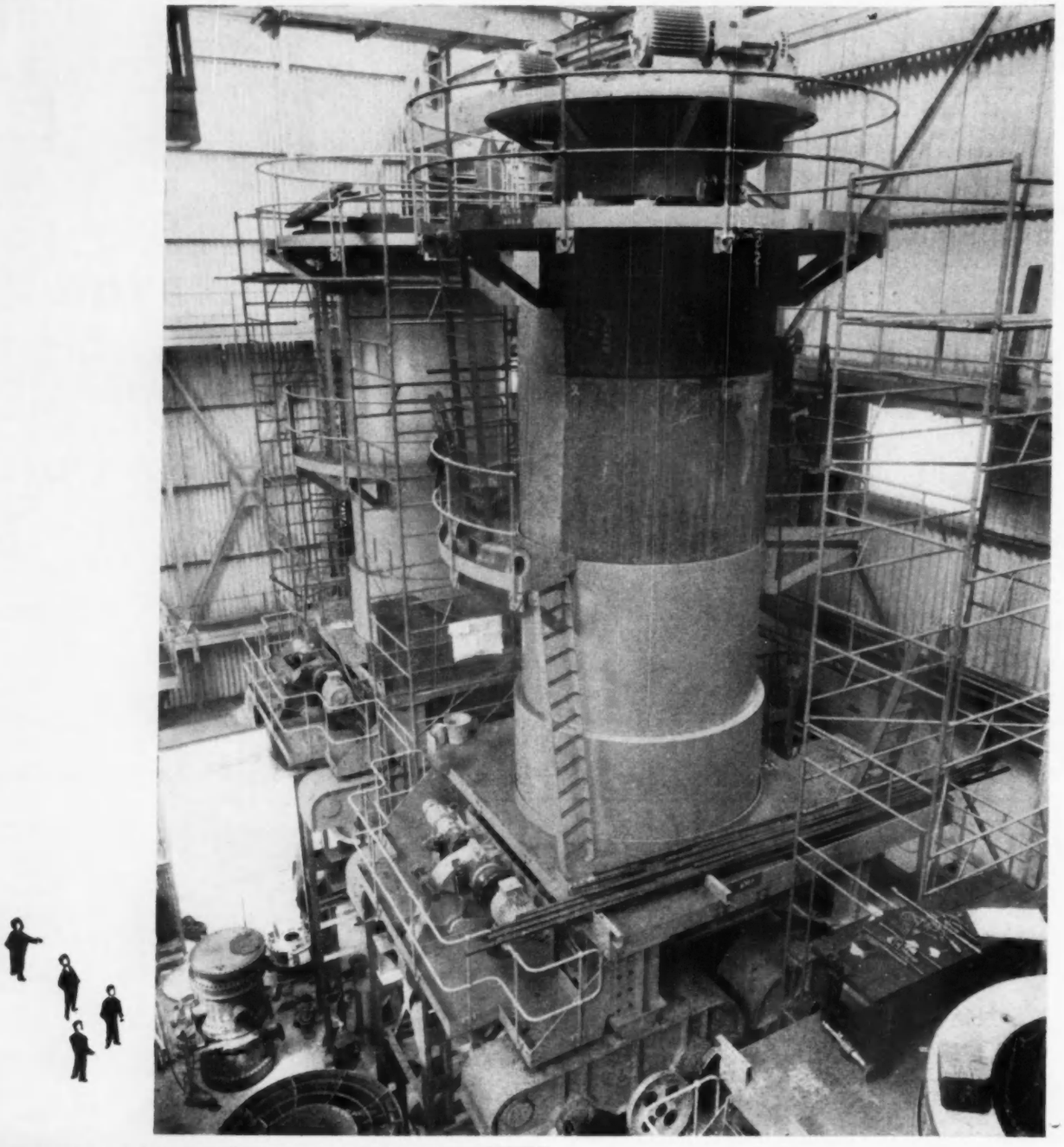

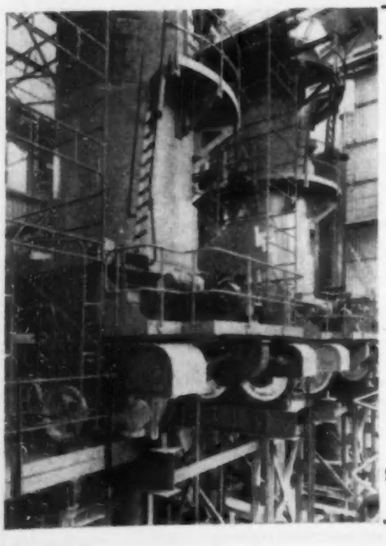

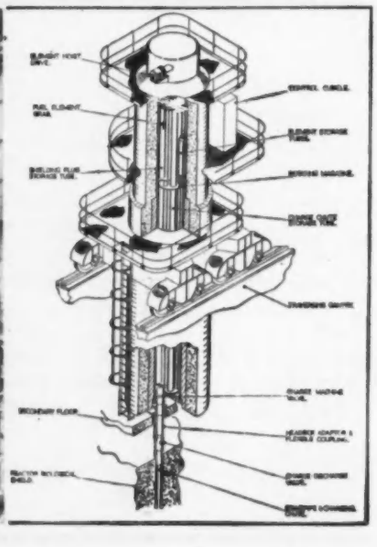

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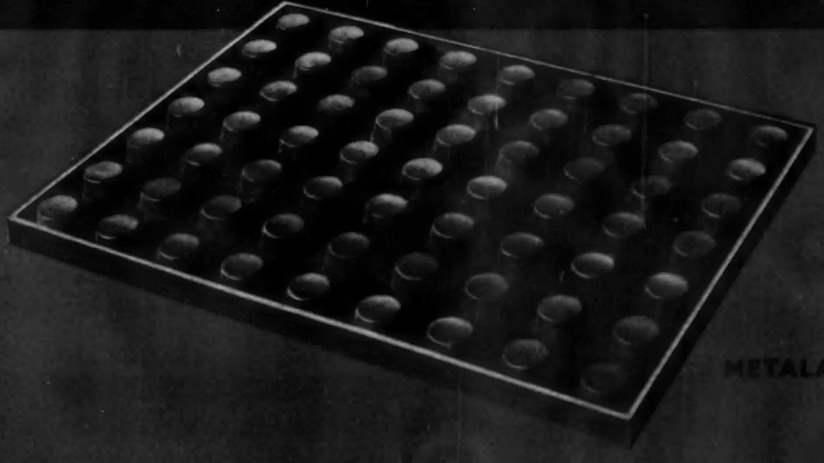

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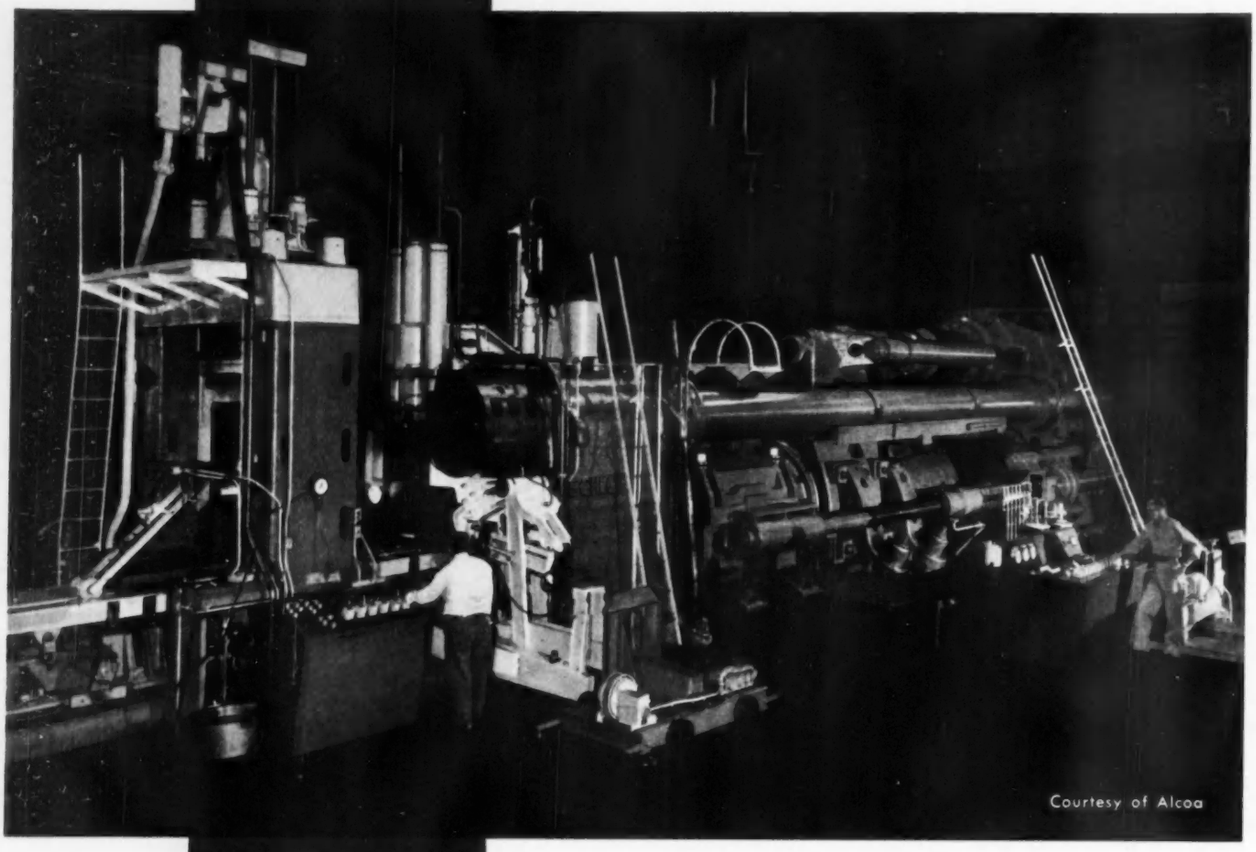

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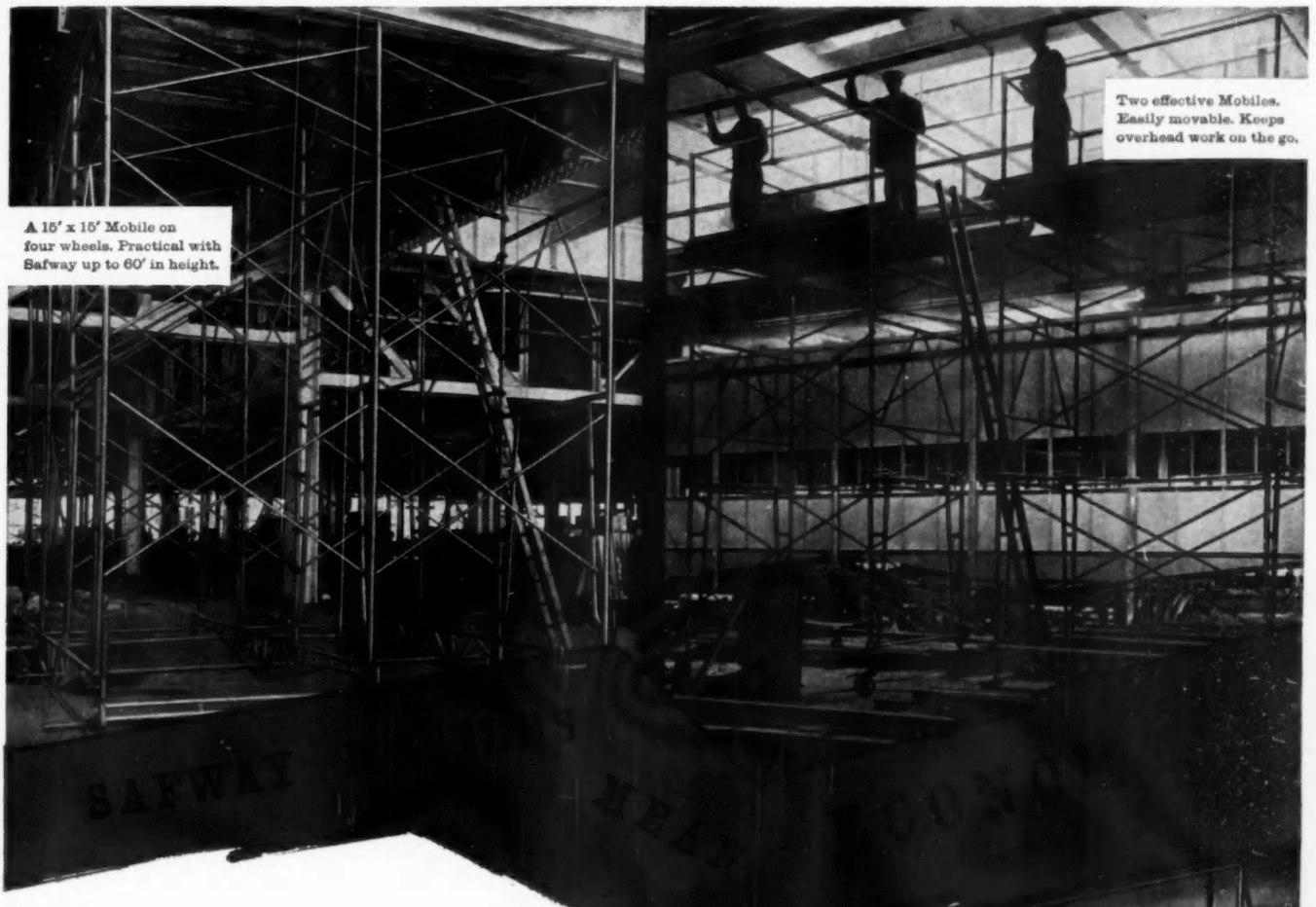
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built on the spot without delay

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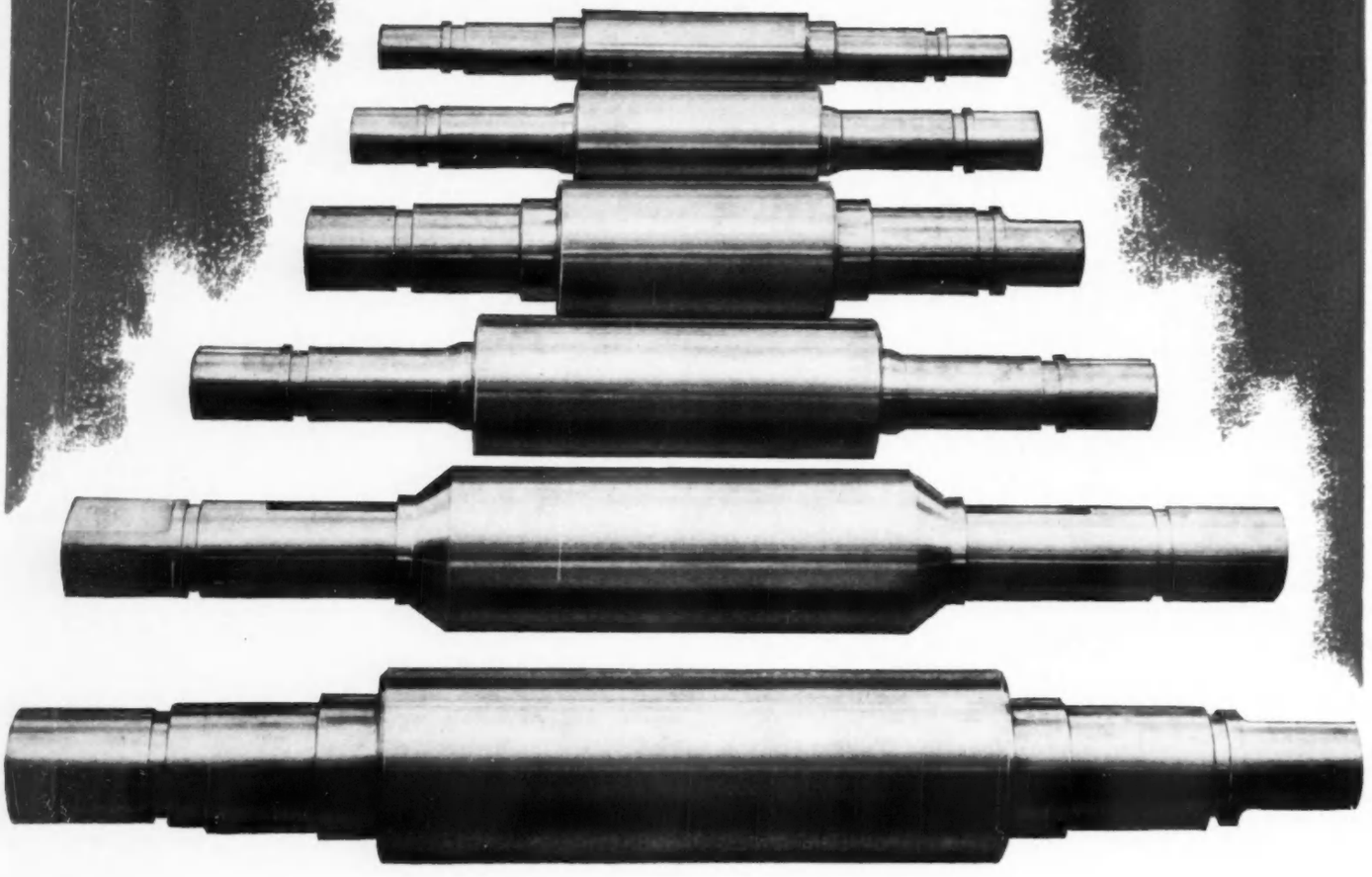

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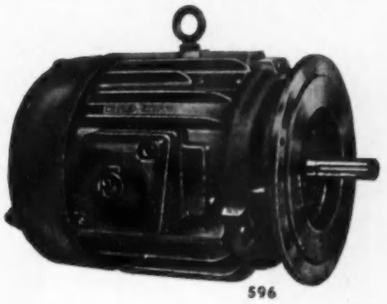
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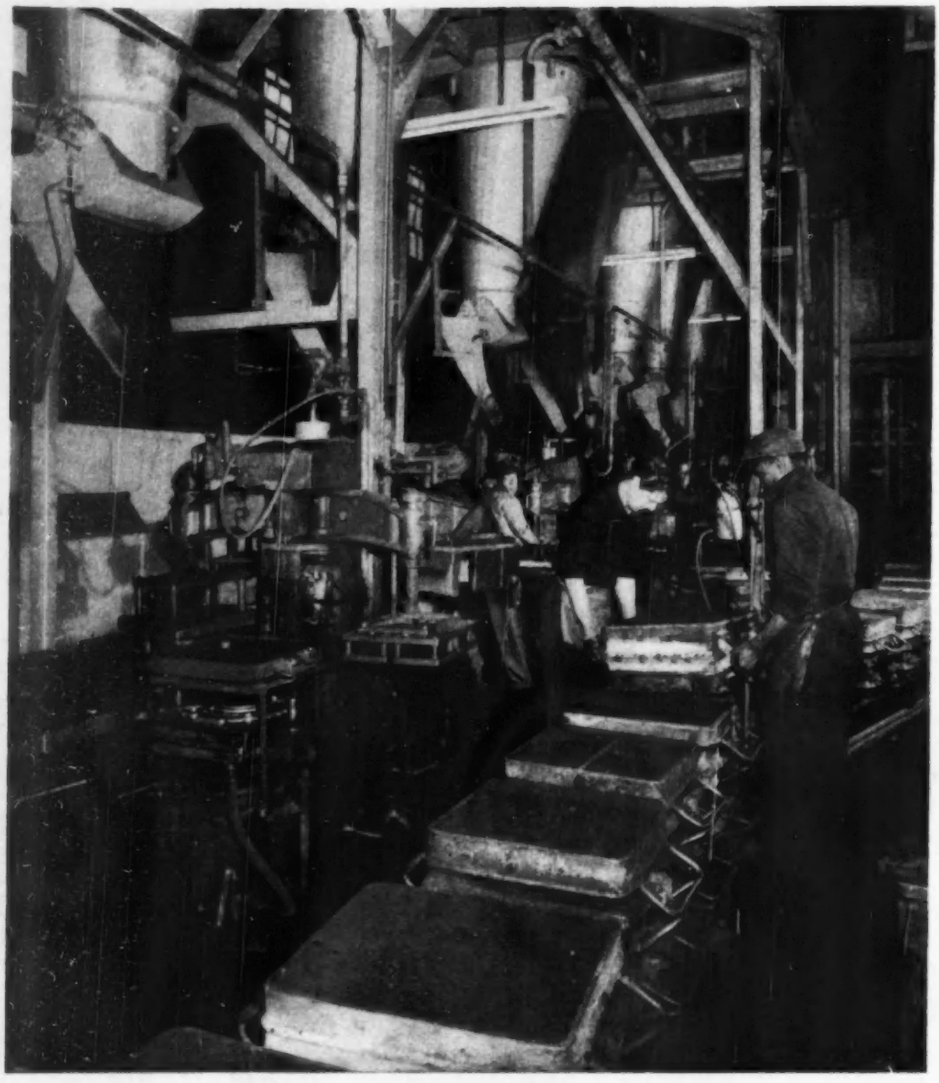

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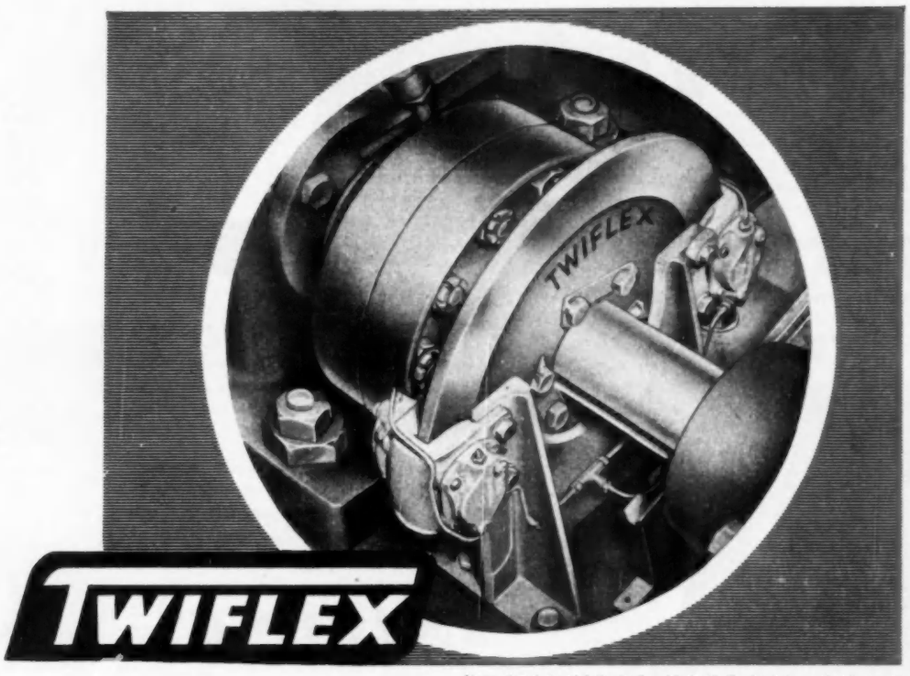

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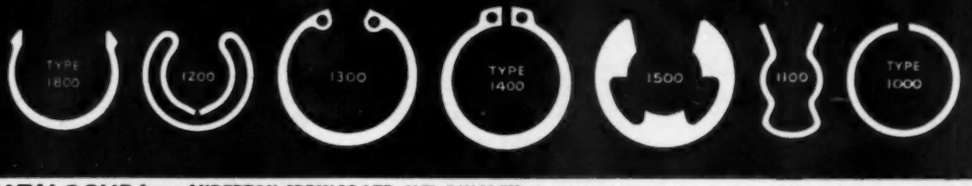

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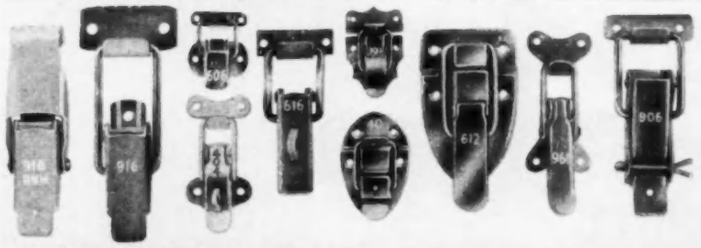

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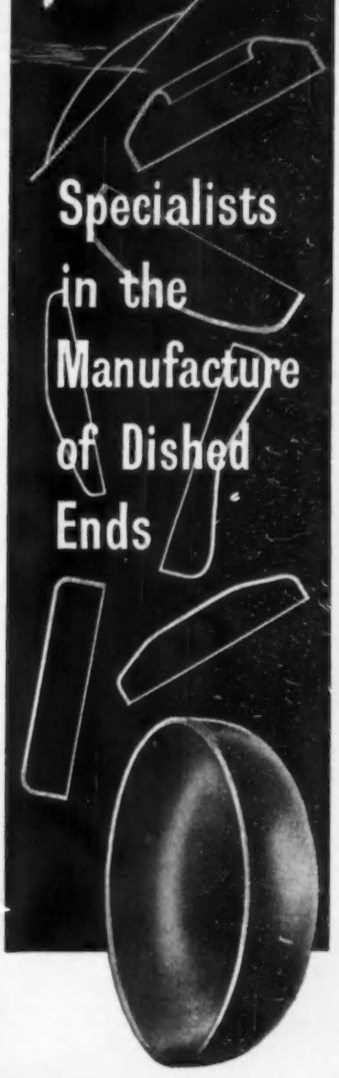

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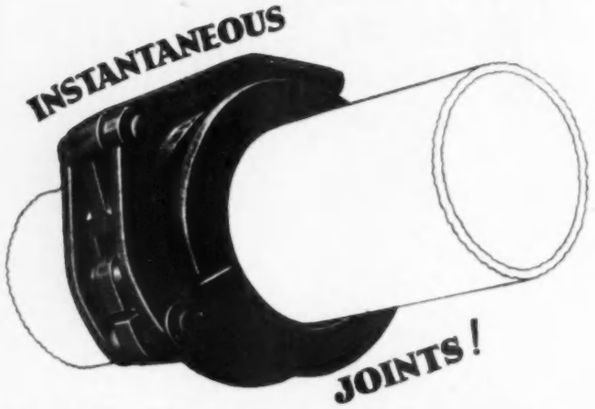

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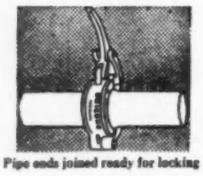
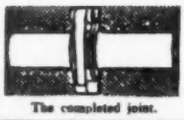


Pipe ends joined ready for locking



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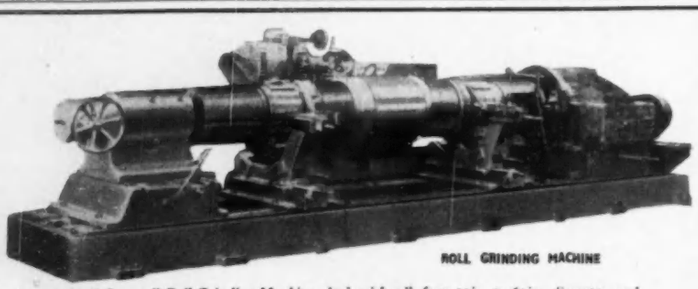

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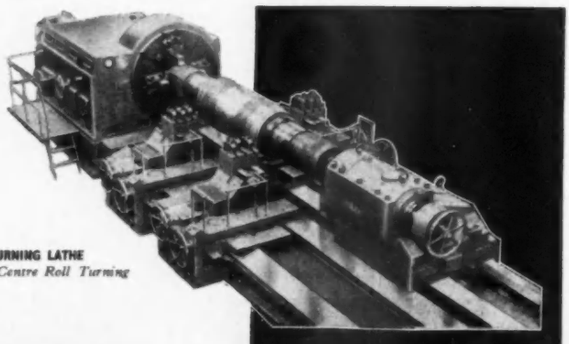
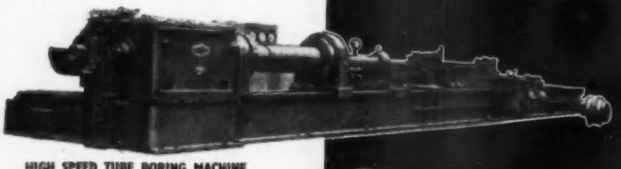
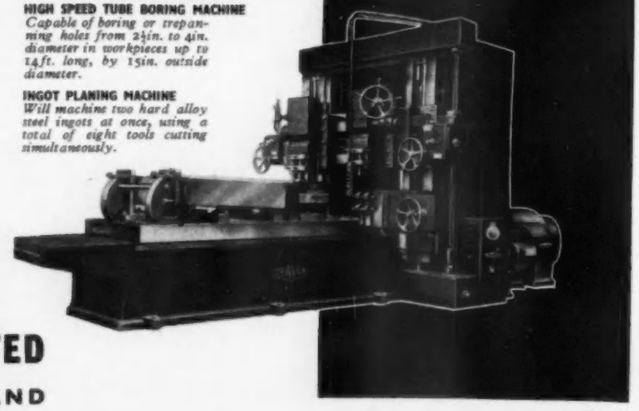


ROLL TURNING LATHE
40½in. Centre Roll Turning Lathe.



HIGH SPEED TUBE BORING MACHINE
Capable of boring or trepanning holes from 2½in. to 4in. diameter in workpieces up to 14ft. long, by 15in. outside diameter.



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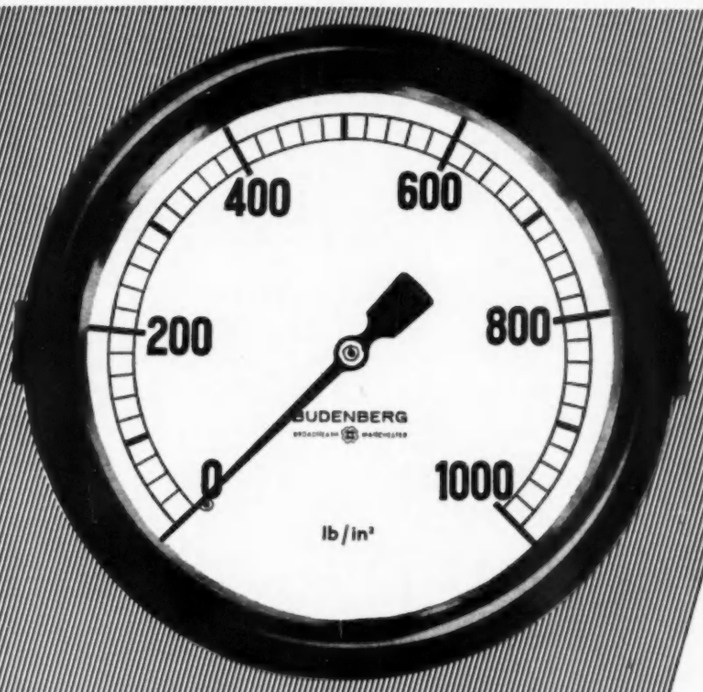

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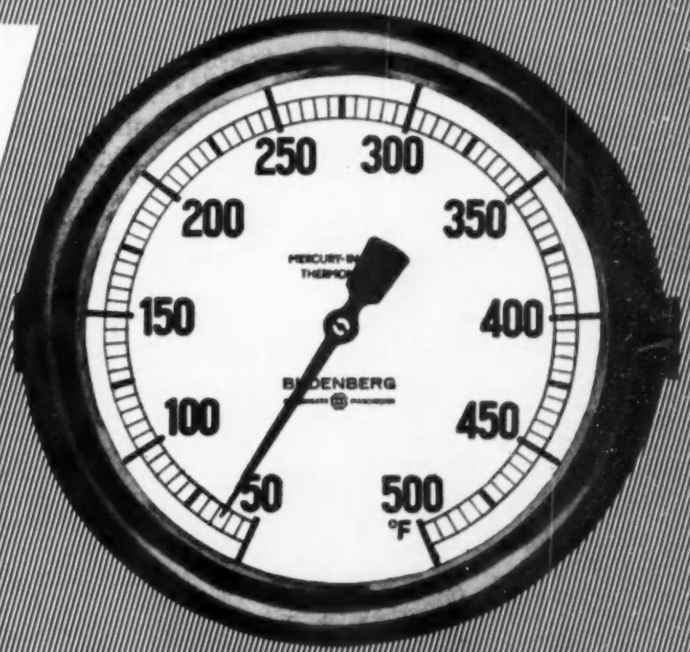

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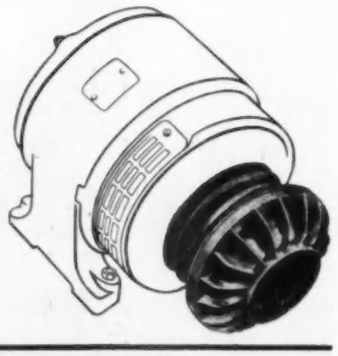

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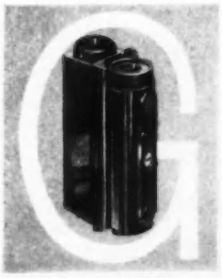

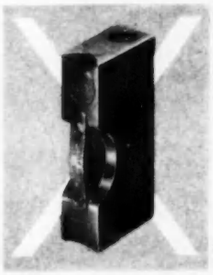

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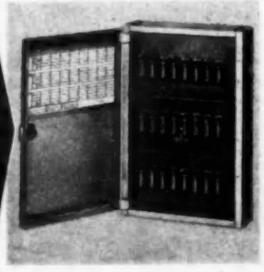

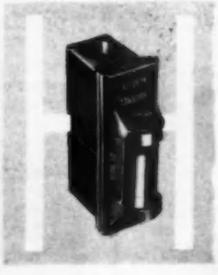

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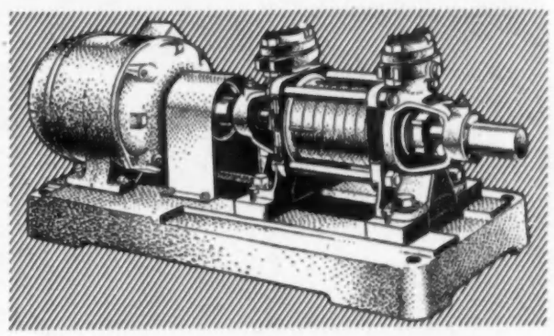

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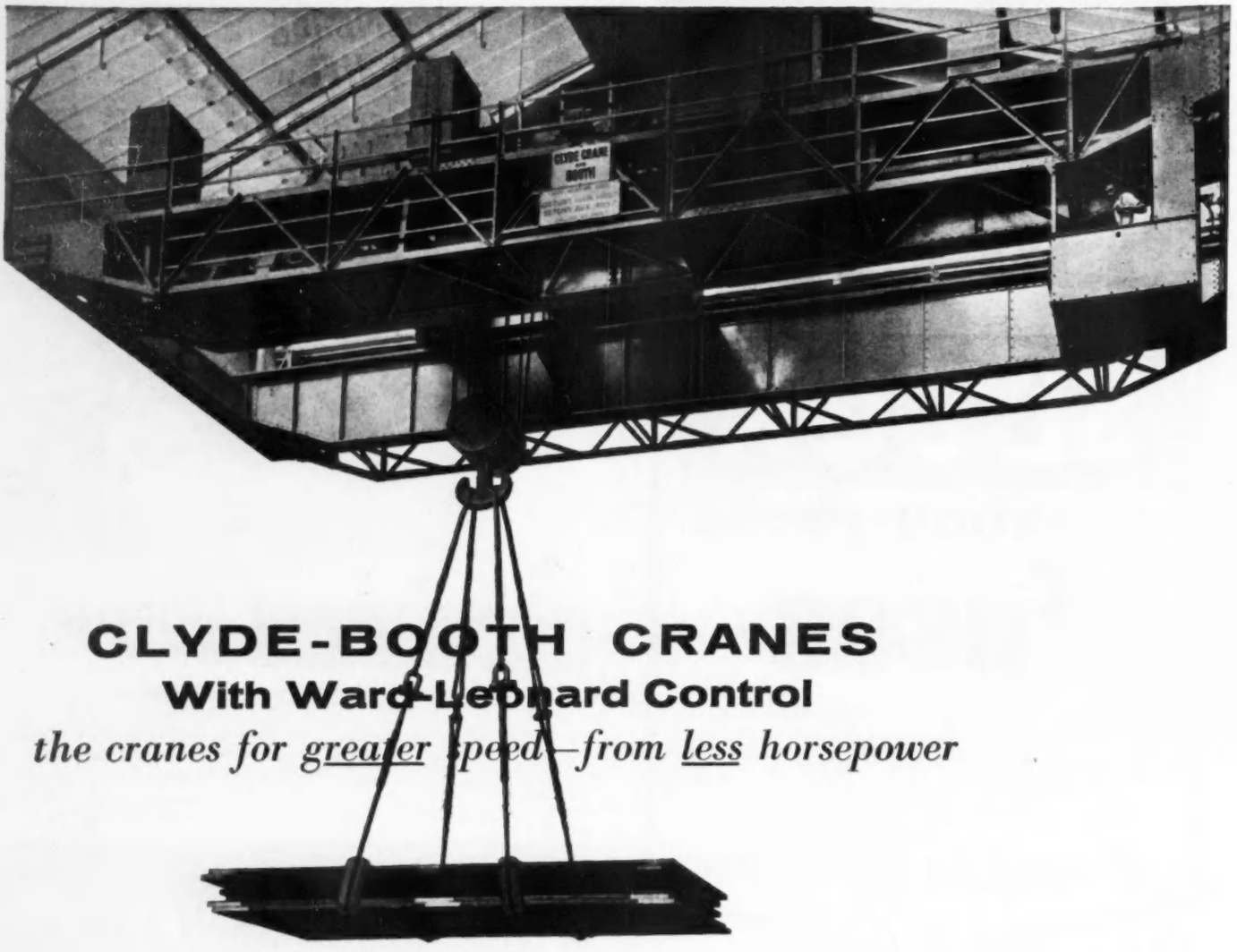

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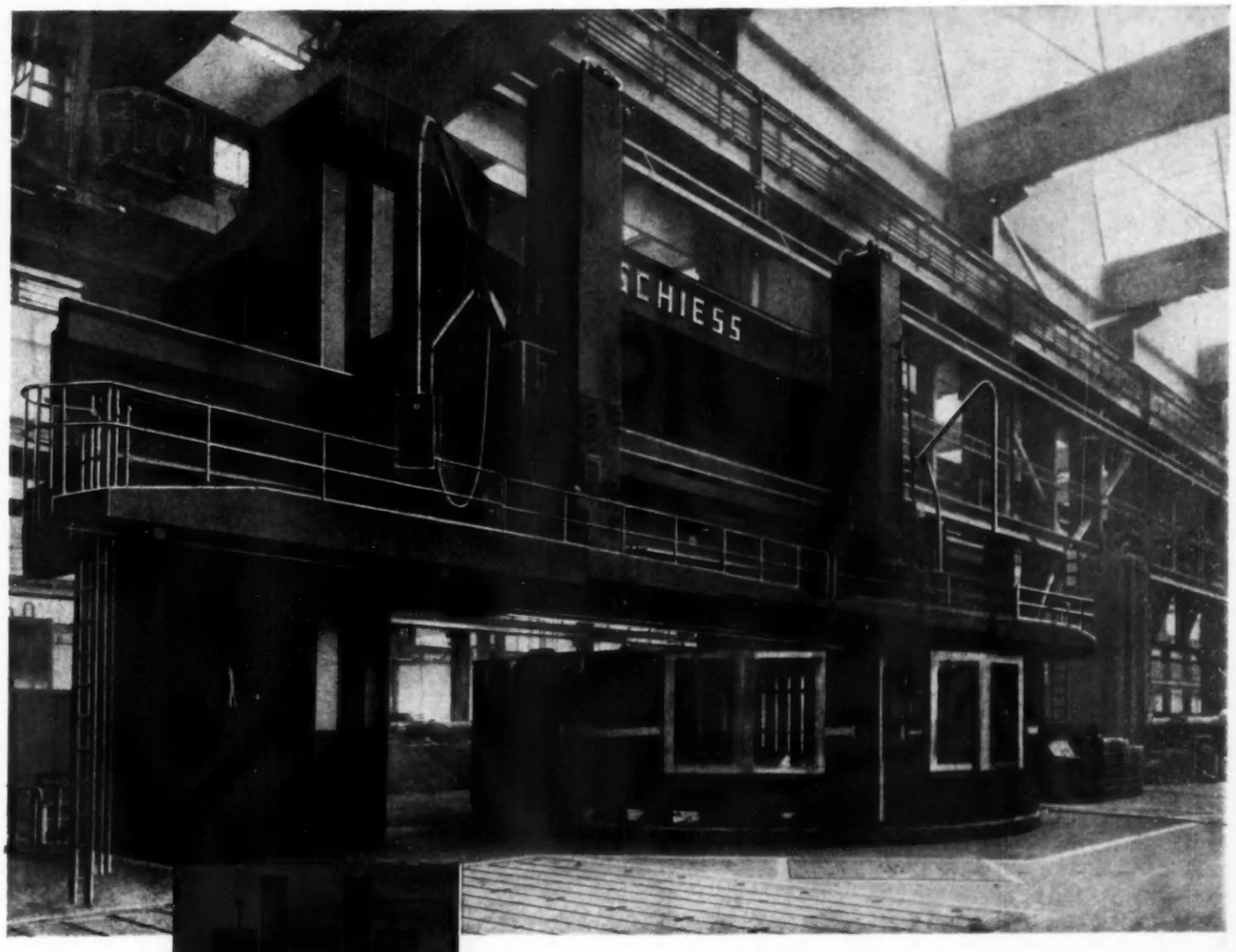

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Dia. of outer ring table	33 ft.
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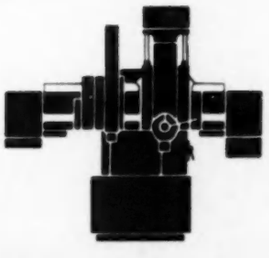

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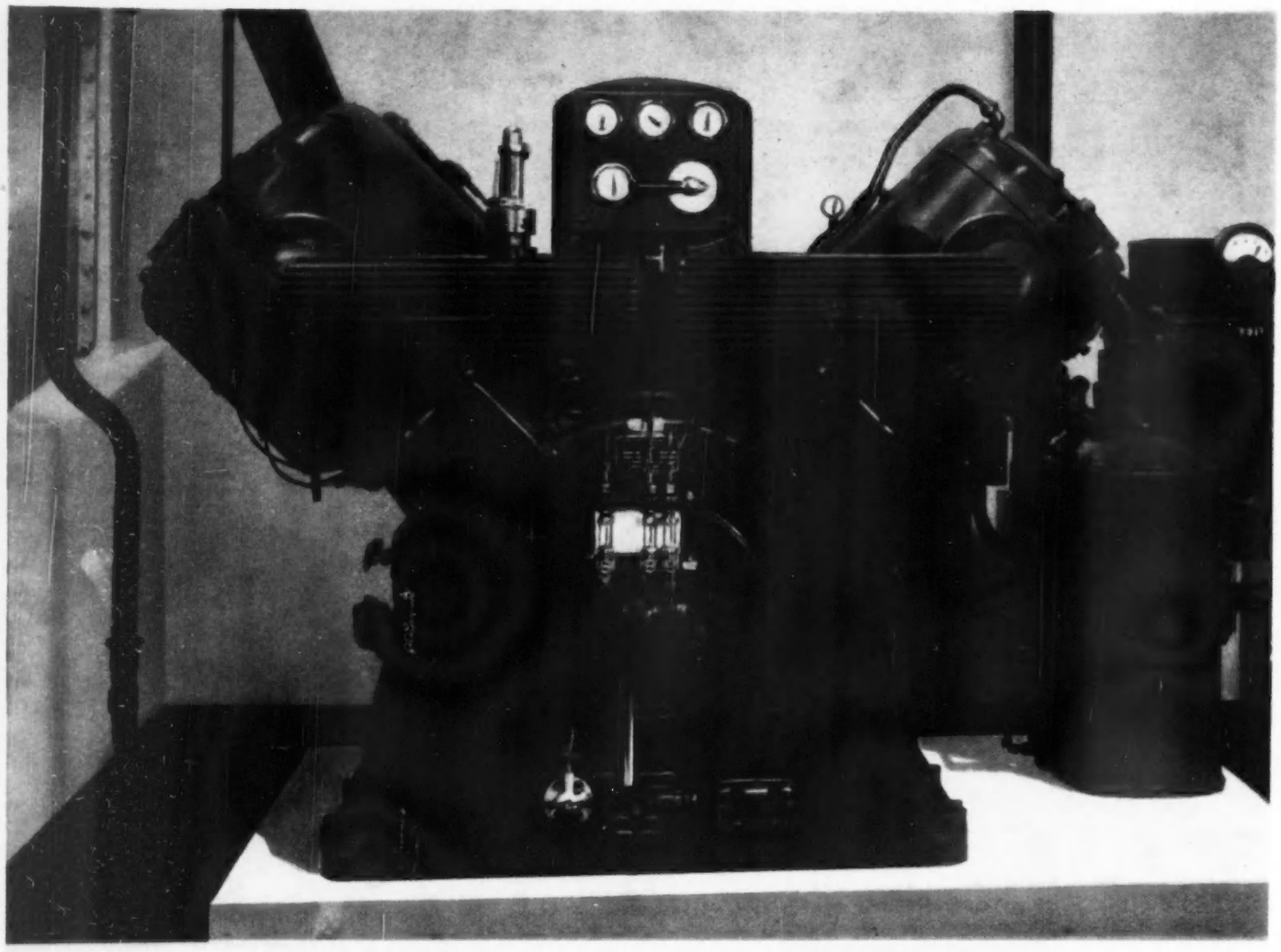

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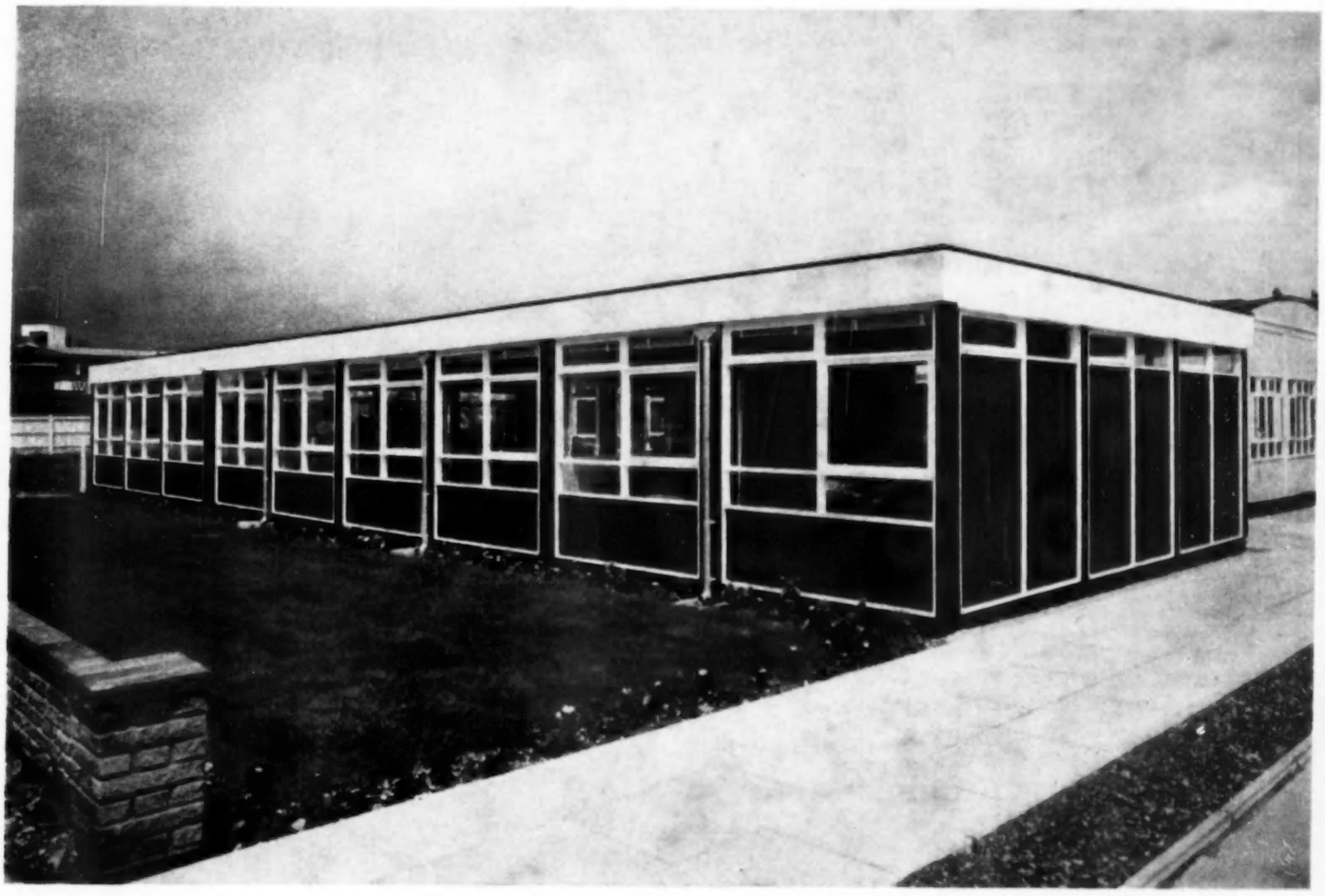

Part of an office extension at Worthing for Messrs Lloyds Bank Ltd, in all 18 Terrapin Pack Units with a floor area of 3,600 sq. ft.

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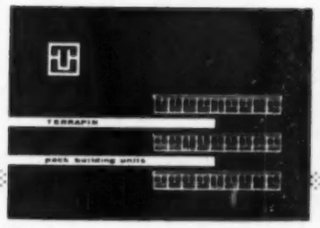

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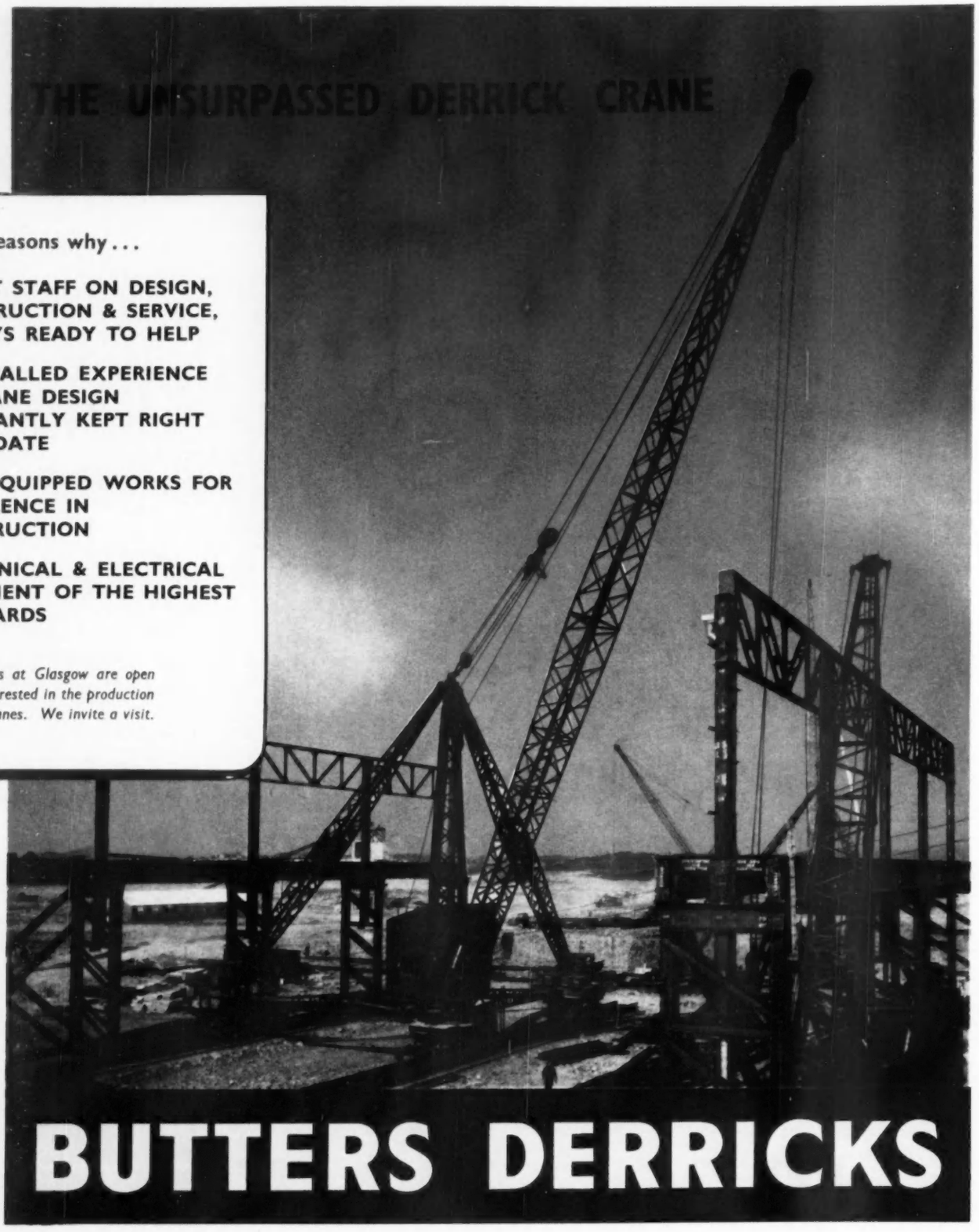

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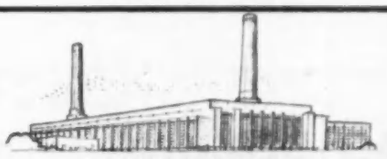

CEMENT PRODOR *is used for these power station chimneys*

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to storage and transport tanks and pipelines; for industrial processes; and linings to vessels for foodstuffs, beverages and aviation fuels. Available for bonding or spraying on site in a variety of forms.

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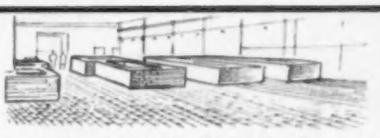
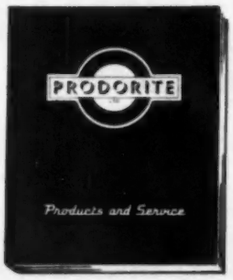


Corrosion resisting floors and walls in Acid Pickling shop

The products and services of the Prodorite Organisation extend from the manufacture and supply of materials to complete constructions carried out by the Contracting Department to customers' requirements. Prodorite products give complete protection from atmospheric conditions, chemical corrosion and mechanical wear and tear of any sort.



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This stiff-cover publication contains 24 pages of invaluable information about the products and services of the Prodorite Organisation. It includes photographs of actual installation and details of the Prodorite research, development and consultation services. Technical information about individual products is also available in leaflet form. Please quote publication reference number : **P.118**

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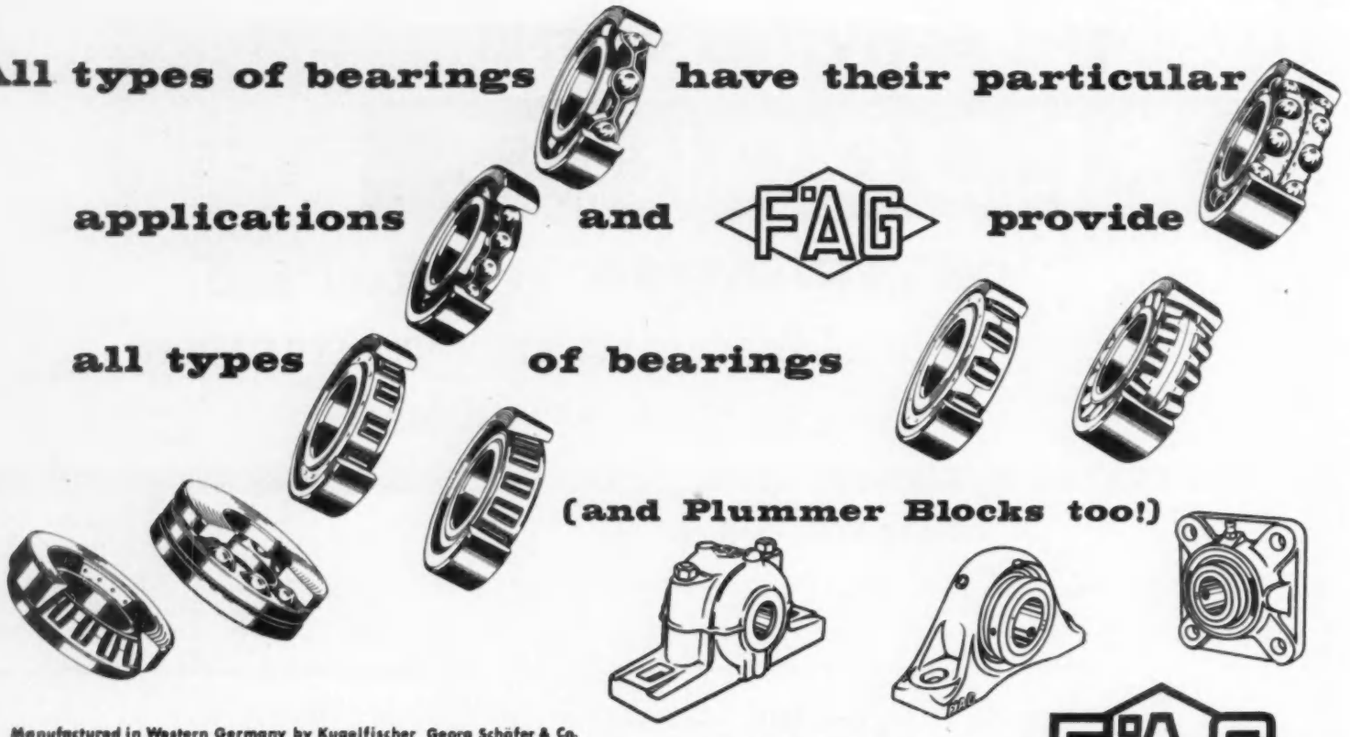

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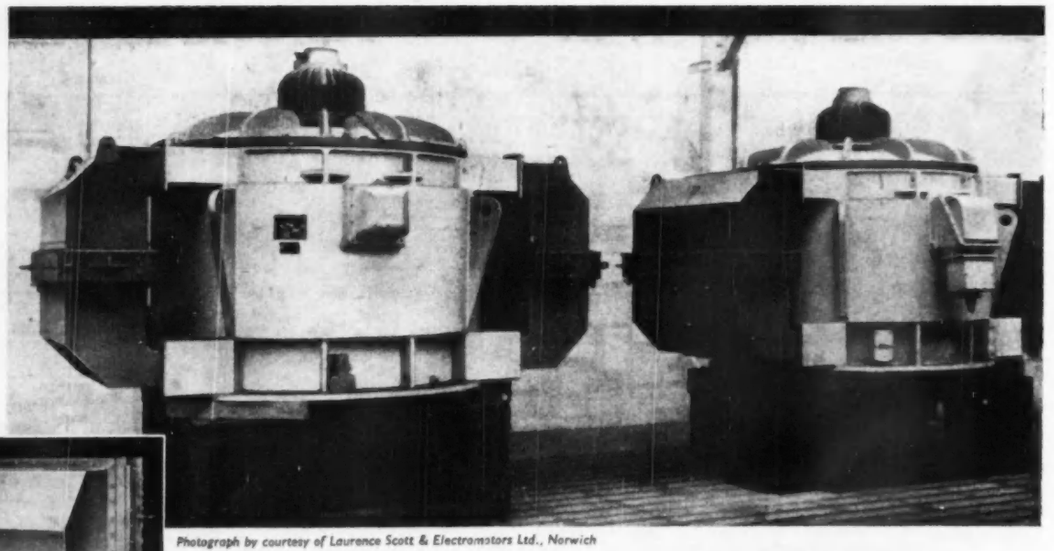
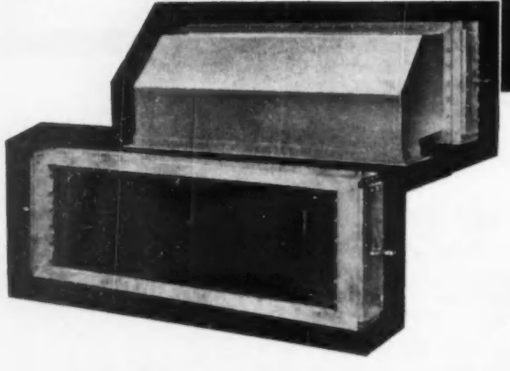


Right: 2 (of 8) 1600 h.p. induction motors. Vertical spindle, closed air circuit type with water coolers by Spiral Tube. For pump drives, Brooklyn Pumping Station, Melbourne.



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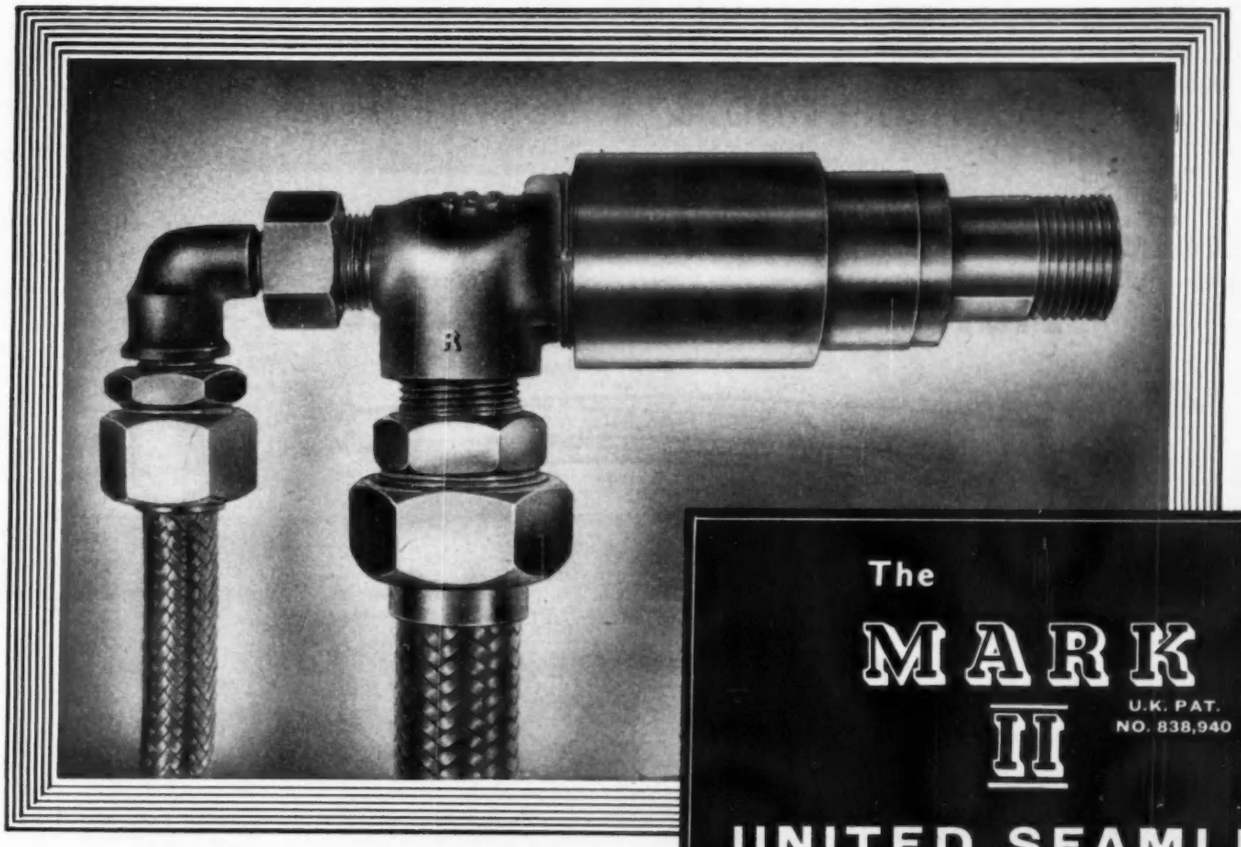

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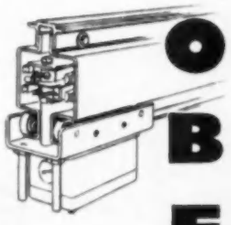

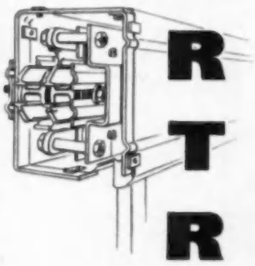

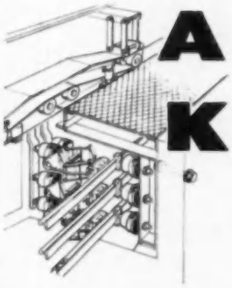

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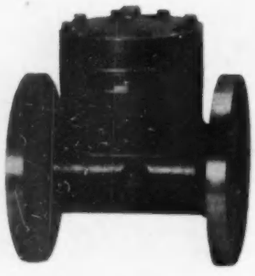

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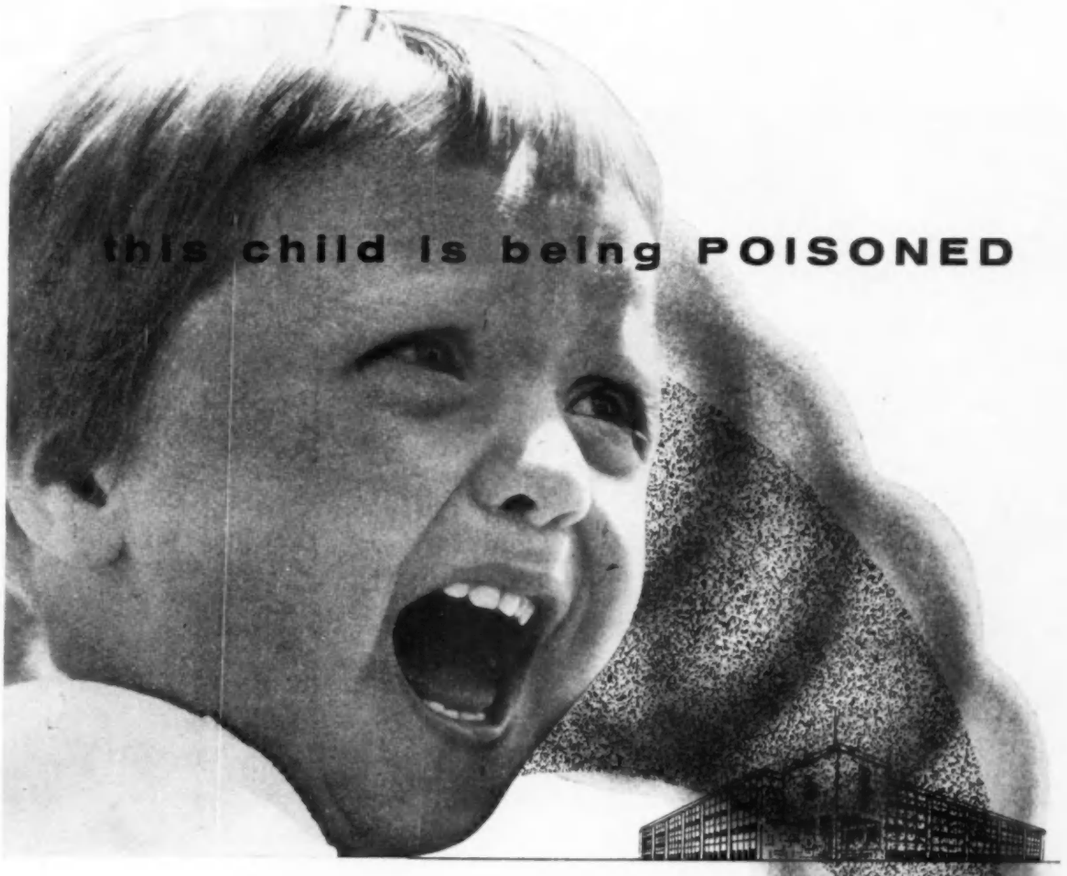

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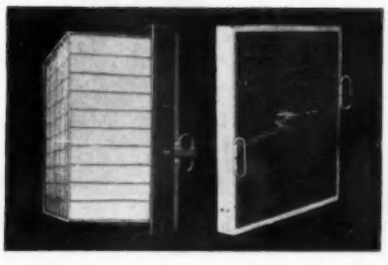

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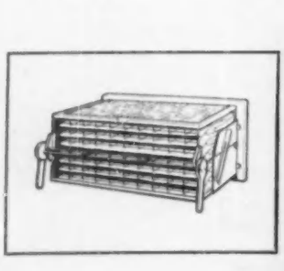

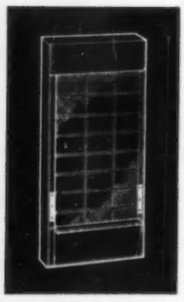

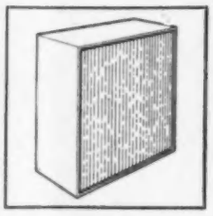

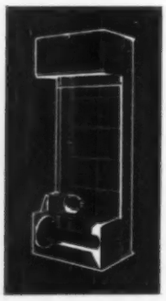

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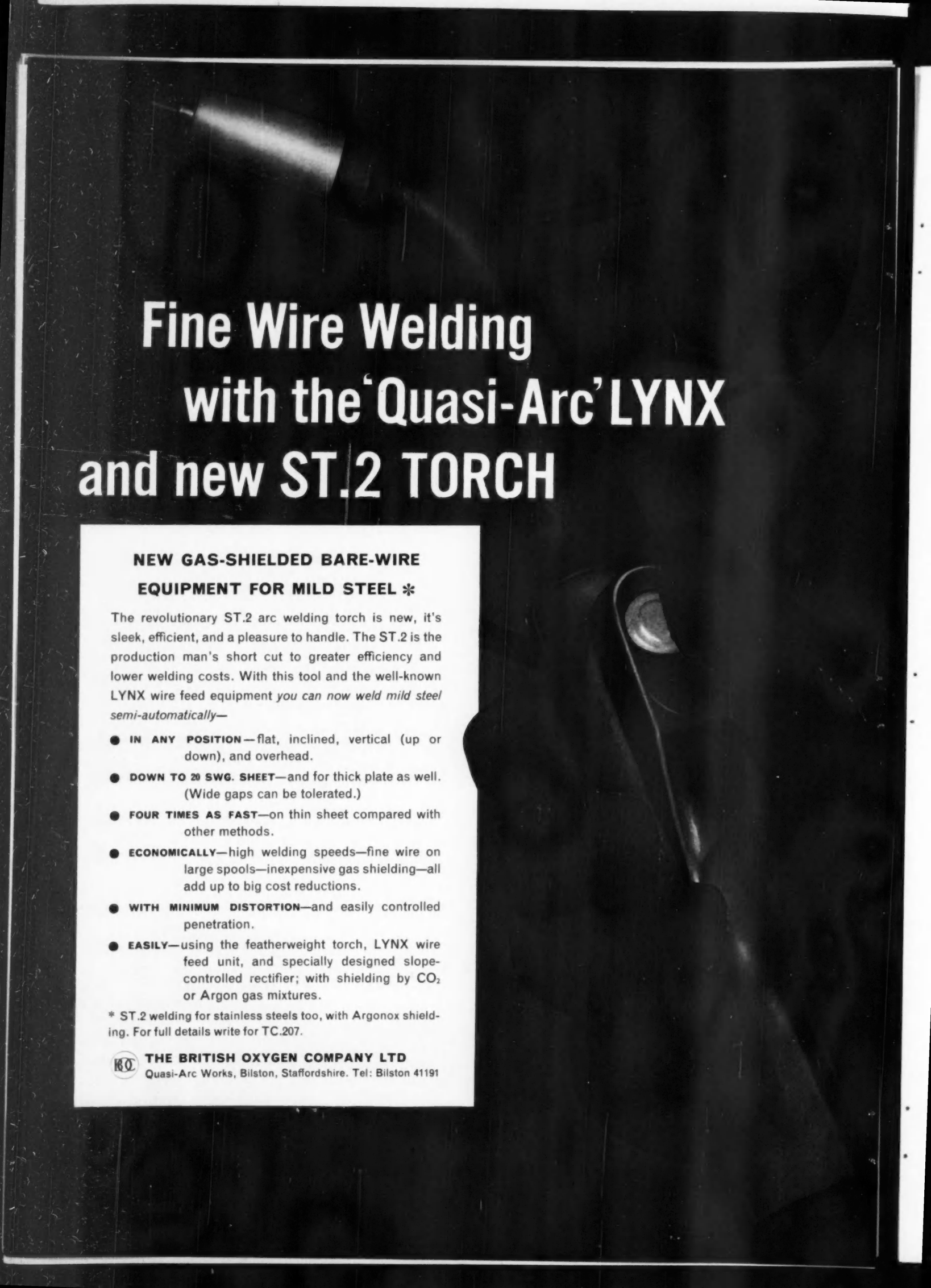

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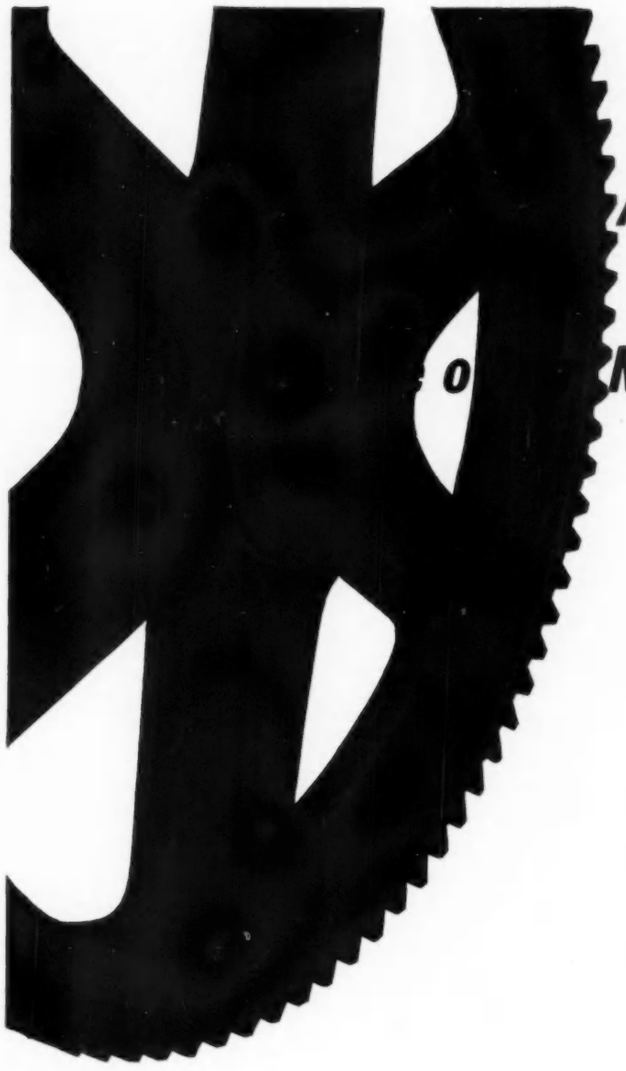

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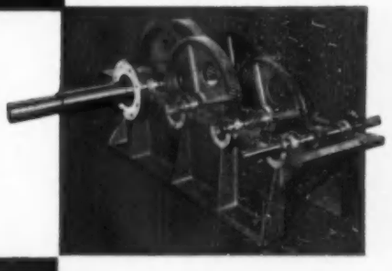

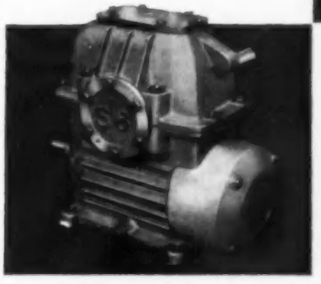

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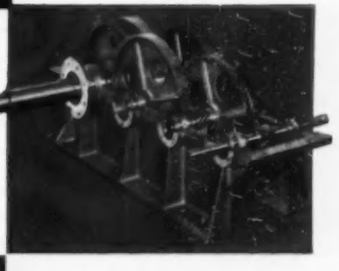

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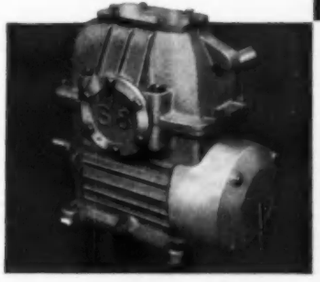

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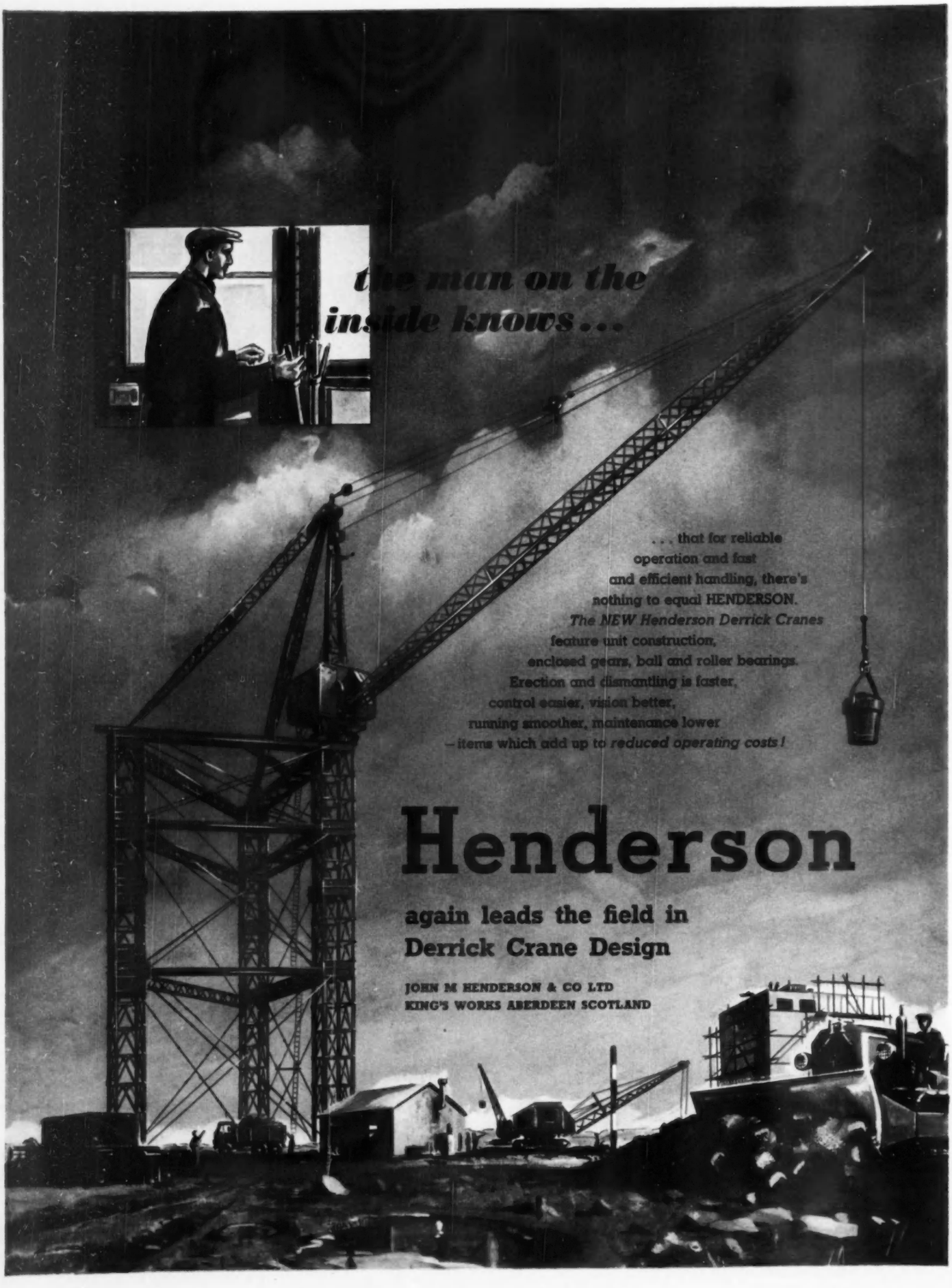
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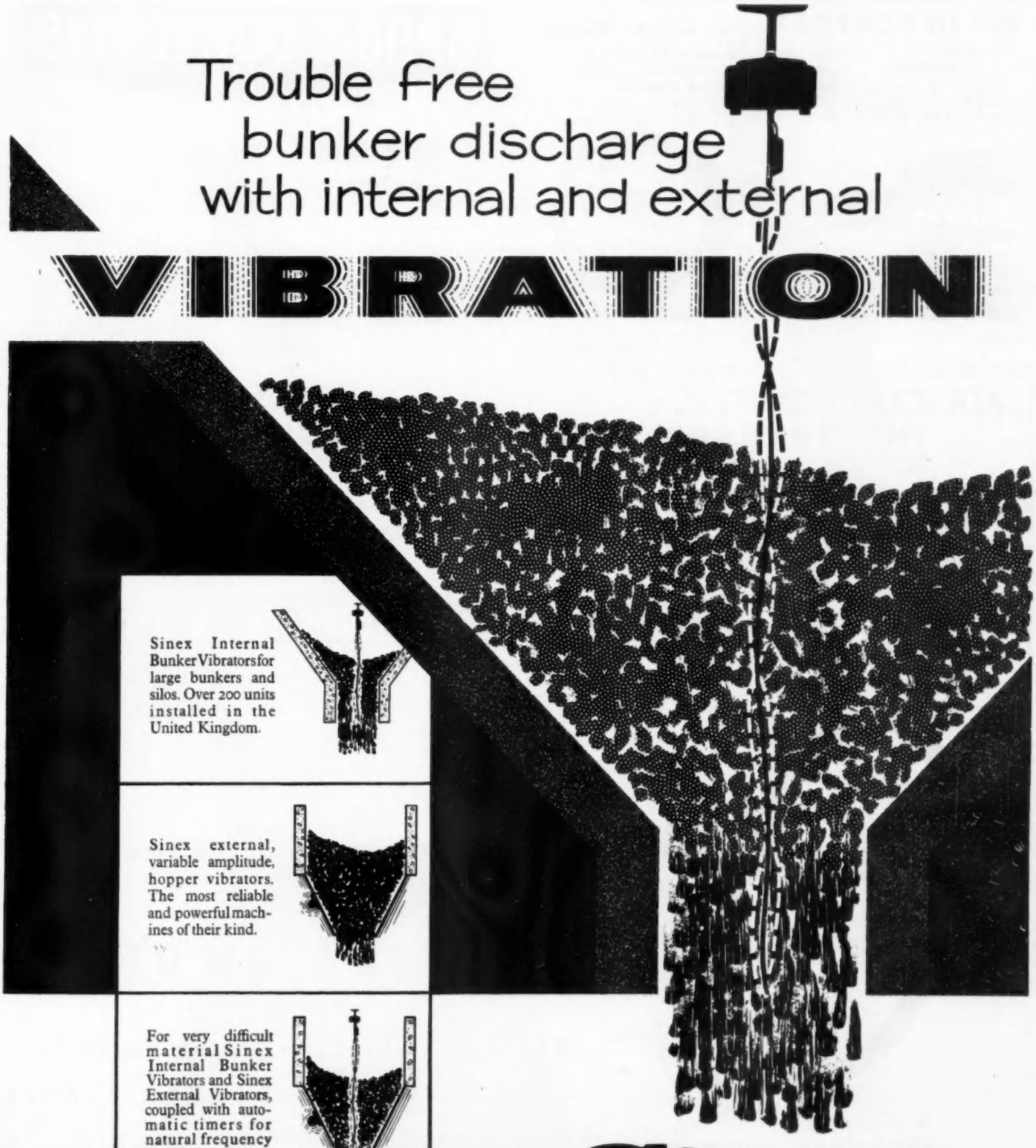

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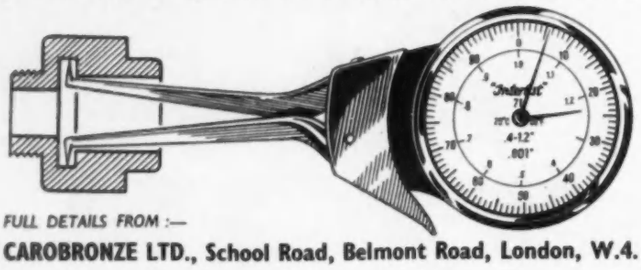

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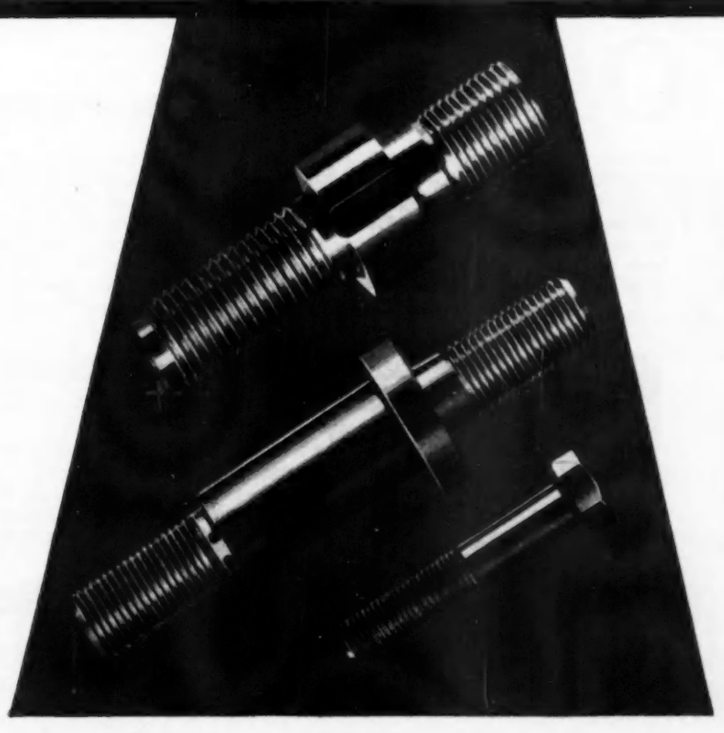

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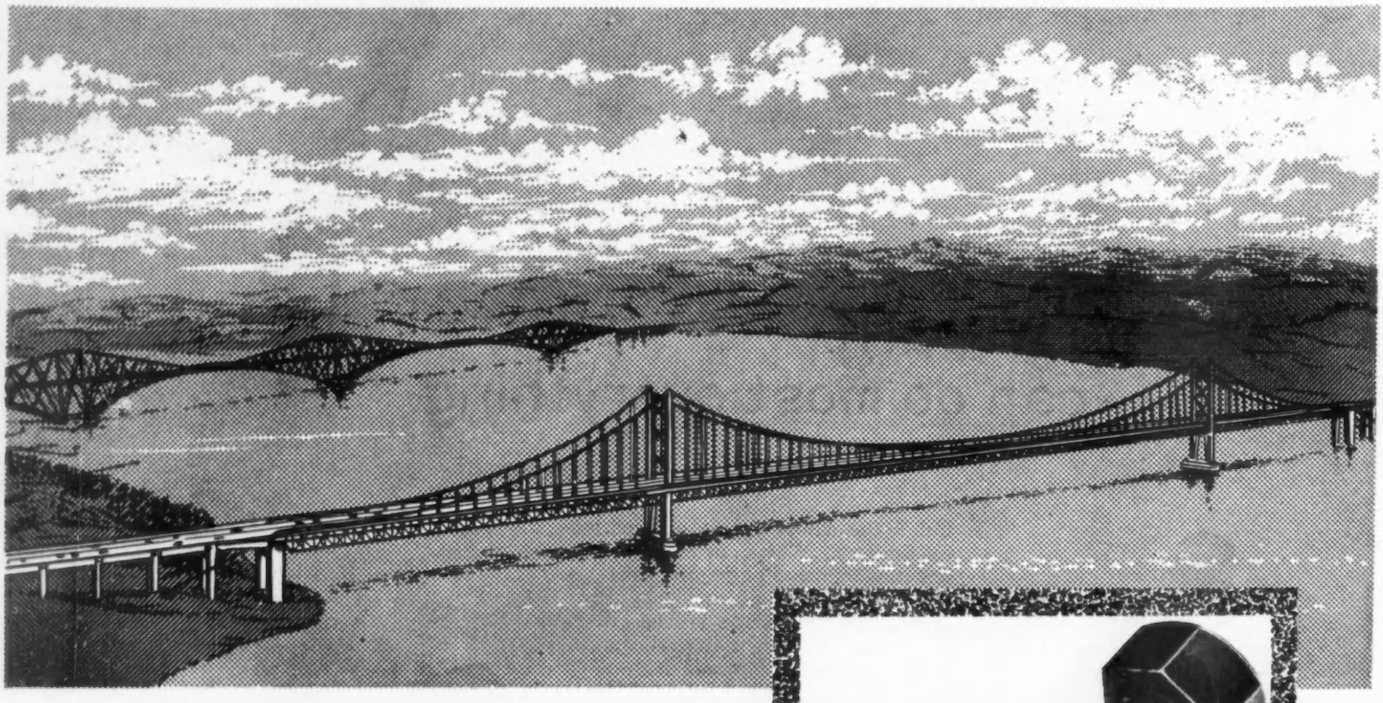

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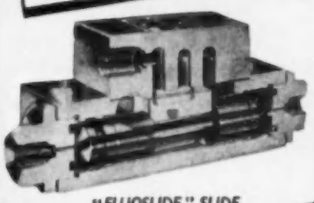

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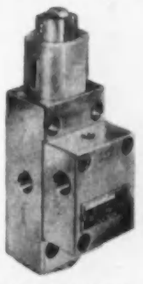

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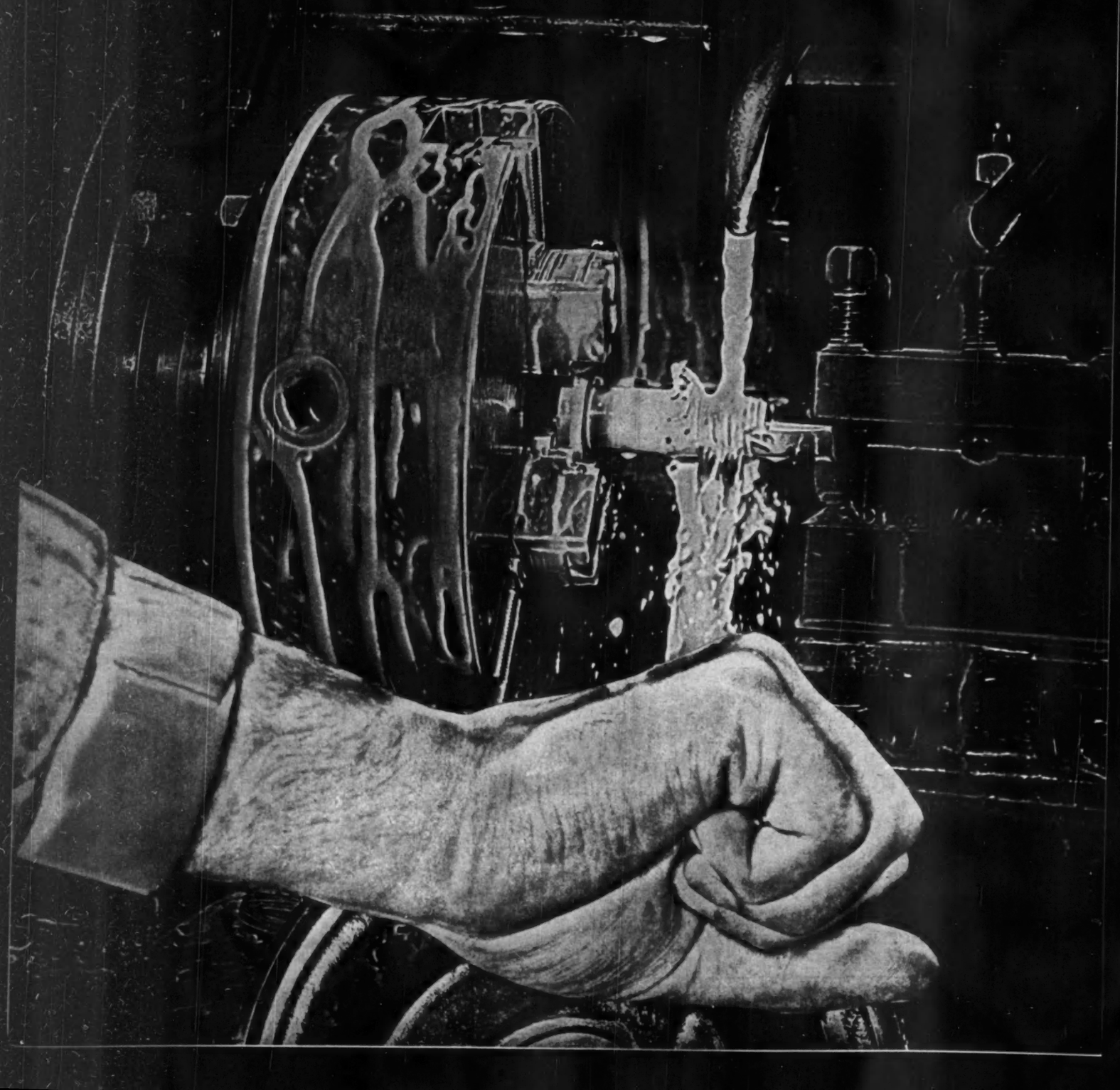

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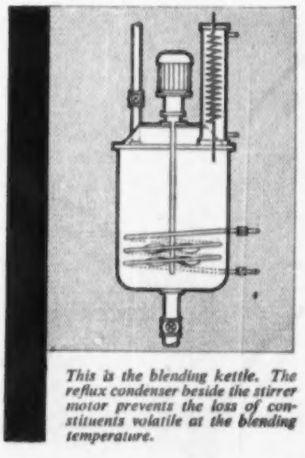

This is the blending kettle. The reflux condenser beside the stirrer motor prevents the loss of constituents volatile at the blending temperature.

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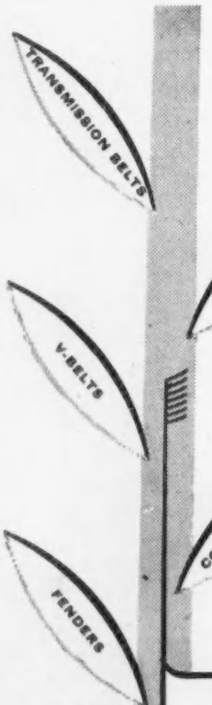

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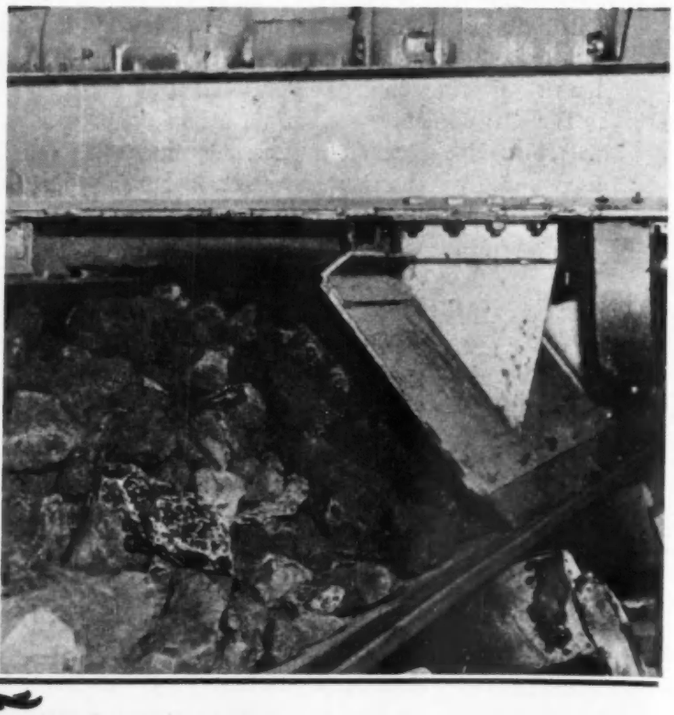

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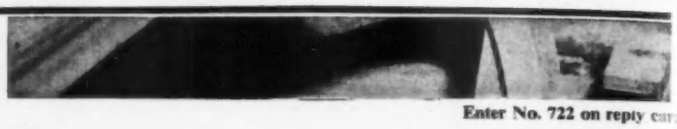

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THE ENGINEER

No. 5469 NOVEMBER 18, 1960 Vol. 210

MACHINE TOOL ACTIVITY

Elsewhere in this issue we print the conclusions reached by a sub-committee of the Machine Tool Advisory Council appointed to consider Professor Melman's Report to the European Productive Agency. The chairman of the sub-committee was Sir Steuart Mitchell of the Ministry of Aviation and there were representatives on it of makers and users of machine tools and of the Amalgamated Engineering Union. Professor Melman's report has, of course, never been published; but he has himself made his views widely known. His views relate to machine tool production in the whole of Western Europe and only in that context have they relevance to the British industry. As the sub-committee rejects the Professor's main recommendation that mass production of machine tools must be introduced rapidly into the machine tool industry of Western Europe and most of his other recommendations as well, the report of the sub-committee might easily have proved a dull document. In fact, however, the excuse has been seized for the sub-committee to go well beyond the letter of its terms of reference and to make its own criticisms and suggestions of and about the British industry. A substantial section of the report is entitled "Other Aspects of the United Kingdom Machine Tool Industry" and it studies a number of the more serious criticisms which have been directed against the industry since the war, finding many of them in varying degrees justified. In particular it stresses the over-concentration of the industry on the production of standard types and draws the conclusion that it "springs . . . from the lack of a sufficiently intensive development effort." Attention is drawn to shortage of specialised staff for research and development and to the low present rate of research and development by the industry. All interested in the fortunes of the machine tool industry will find the report well worth reading in full.

We have commented before that within the last year or two the machine tool industry has lost much of that irritating complacency with which it was wont to answer criticisms. Another document, which we also print on another page of this issue, was issued last week. It summarises the recommendations of the report on "the Research and Development Requirements of the British Machine Tool Industry" which was prepared jointly by the Department of Scientific and Industrial Research and the Machine Tool Trades Association after a survey had been carried out by the former body. Those recommendations, it will be seen, relate in particular to the training of men in machine tool technology and to the ways in which the industry and the D.S.I.R. could jointly improve machine tool research. The encouraging factor in relation to both the report of the sub-committee and that of the D.S.I.R. is that really energetic action is at last being taken by the industry to remedy defects that have so often in the past been pointed out to it with very little effect. The industry as a whole has at last recognised that there really is a need for more research and an equal need for more people within the industry trained to appreciate and apply the results of research. A recent conference on machine tools at Birmingham — such conferences are now to be held annually — illustrated very clearly how few practical machine tool designers can at present understand what research workers are doing and how few research workers in this field have much appreciation of the needs of practical designers. As we commented at the time the two groups present at the conference were hardly able to comprehend one another, a deplorable state of affairs! As a consequence of this enhanced interest in research, universities and colleges of advanced technology are laying on more courses and developing schools of research and higher training. As was announced some time ago, the Association is also to establish a Machine Tool Industry Research Association, and a much closer relationship than has hitherto ruled is to be developed with the National Engineering Laboratory at East Kilbride. This generally more self-critical attitude within the industry has stimulated certain firms to embark upon quite ambitious research and development programmes of their own. A century ago Britain led the world in the design of machine tools. It certainly does not do so to-day. Nor, sadly, can it be expected to do so again for many years to come. But a "wind of change" is now blowing. Maybe, given time, it will carry the industry to the forefront of the world once more.

RADIOACTIVE ISOTOPES FROM C.E.G.B. REACTORS?

The Electricity (Amendment) Bill, which was presented by the Minister of Power in the House of Commons recently, is probably one of the less exciting items of legislation to be introduced in the present parliamentary session. But it has the positive merit that it seeks to remove an unnecessary restriction. At present, by the terms of Section 2(7) of the Electricity Act, 1957, the Central Electricity Generating Board is prevented from manufacturing anything except what the Board itself, or any Area Board, may require for research or development or for repair or maintenance. Now it is proposed in the new bill to empower the Board to produce radioactive isotopes in the nuclear reactors at any of its generating stations "for sale or supply to any other persons". In the memorandum accompanying the Bill it is explained that the exercise of the powers proposed will entail "some additional capital outlay which, on present computations, is not expected to exceed £250,000". The Bill provides that the necessary capital shall be raised through the usual channels applicable to the nationalised industries.

It is perhaps too early to forecast what use is likely to be made by the Board of the powers envisaged in the new Bill. When the first nuclear power stations come into service, next year, it is hoped, the Board's efforts will be firmly concentrated on the immediate task of operating them to generate electricity as smoothly and efficiently as possible. Until that stage of satisfactory operation has been reached the manufacture of by-products will be a secondary consideration. However, the subsequent prospect of being free to produce radioactive isotopes for sale or disposal otherwise, is certainly intriguing. Clearly the

Board's power reactors will be eminently suitable, without modification, for the production of radioactive isotopes on a considerable scale, depending on the availability of vacant channels in the reactor core. Handling and storage of the irradiated materials should present no technical problems, since the procedure will be similar to that adopted for the irradiated fuel elements. Marketing the isotopes may be less straightforward, but since the Board is to be offered the convenient alternatives of "selling or otherwise supplying" these products, the obvious medium of distribution would seem to be the U.K.A.E.A. Radio Chemical Centre at Amersham, which is strongly organised and well experienced in this very enterprise. The commercial aspects of producing radioactive isotopes in power reactors look very attractive. If the Board should engage in the venture it will be able, with this flexible method of production, to match the output with the demand. Its problems then are likely to be much less embarrassing than those it has faced in disposing of its main waste product—fuel ash—and in developing commercial uses for it.

WEIGHTS AND MEASURES

Many of our readers will have noted that, as foreshadowed in the Queen's speech on the occasion of the opening of Parliament, a Bill has been presented for both first and second readings in the House of Lords "to make provision with respect to weights and measures, and for connected purposes." While much of the Bill is concerned with trade the first part deals with the "basic units of measurement and the physical standards which represent them," matters which are of professional concern to engineers. The Bill seeks to modernise much which is out of date. That such modernisation is long overdue cannot be denied. Our weight and measures are largely governed by the Act of 1878, and the Hodgson Commission recommended reform nearly ten years ago. It was proved beyond all doubt in 1947 that the imperial standard yard was becoming progressively shorter; the National Physical Laboratory accordingly continued to base its non-statutory calibrations in the yard system on length of the imperial standard yard as it was in 1922 (it was fortunate that this could be done through the agency of the interferometry of light waves) until the time was ripe, in 1959, for the adoption for science and technology of an international yard defined as 0·9144m. The difference between the British and the U.S. legal yards has grown by that time to five parts in a million. The U.S. legal yard was last year redefined as 0·9144m. But the British legal yard is still tied to the shortening imperial standard, and will remain so until the legislation reaches the statute book. The new Bill defines the statutory British yard as equal to 0·9144m. also, so that this relationship, equivalent to 1in=2·54cm. (exactly), would be legal for trade and would cease to be merely an approximate equivalent. Thus the yards for science, technology, industry and trade would be all the same. And since by decision of the eleventh Conférence Général des Poids et Mesures, October 1960, the metre was re-defined in terms of wavelengths of light*, both the metre and the yard will be thoroughly stable.

The Bill seeks also to define the pound as 0·453 592 37 kg. This relationship, too, was adopted definitely for science and technology in 1959 and has since been adopted legally by the U.S. and Canada. Though the legal British pound differs hardly at all from the 1959 pound, nevertheless as with the yard the principle of co-ordinating the British and the U.S. pounds in terms of the corresponding metric unit is important. Incidentally, in keeping with the adult status of the Commonwealth and Empire countries, the standards of the basic units of length and mass which will have to be maintained under the Act will be known no longer as "imperial" but as "United Kingdom" primary standards. For many years the imprecision of the definition of the gallon, that is the volume occupied by 10 lb. of distilled water weighed "in air against brass weights, with the water and air at the temperature of sixty-two degrees of Fahrenheit's thermometer, and with the barometer at thirty inches" has been a source of uncertainty in precise evaluation because the prescriptions for the water and the weights and the air are indefinite. The Bill refines the definition by quoting specific values for the densities of the water, weights and air, and it can be calculated that the values chosen lead to the well-recognised equivalents for the present gallon, namely, 4·545 96 litres and 277·420 cubic inches. Of course the well-known disparity between the British and the U.S. gallons (1 U.K. gallon = 1·200 94 U.S. gallons) prevents the equation of these units. Of the electrical units the ampere, ohm, volt and watt are to have their current international metric meanings, or (in common with the metre and the kilogramme) the meaning " . . . appearing to the Board (of Trade) to reproduce in English the international definition . . . "

A most important provision of the Bill which has so far gone largely unnoticed is that for the establishment of a Commission on Units and Standards of Measurement. This Commission would advise the Board of Trade on technical matters concerning units and the Board would be empowered to give effect to its recommendations (with the notable exception of any recommendation to abandon the imperial system in favour of the metric system). It was because of the difficulty of securing parliamentary time for the reform of such apparently mundane matters as weights and measures legislation that in 1960 we are still bound by the law of 1878 (and, indeed, by requirements of the Hay and Straw Act of 1796!) The nine-man Commission proposed is a strong one. It is to be hoped that the Commission will indeed be appointed; its activities will be watched with lively interest.

LATENT HEAT COOLING AND WASTE HEAT RECOVERY IN DIESEL ENGINES

Very opportune was the paper read by Mr. R. Brett-Littlechild before the Diesel Engineers and Users Association on October 20. Dealing with "Latent Heat Cooling and Waste Heat Recovery" it may kindle new interest in a subject which has for long been prominent among those pondered by users of all manner of heat engines. For example, in the dawn of the steam engine era we find Thomas Newcomen taking what must have been the earliest move in the direction of waste heat recovery. This was when dealing with the atmospheric engine erected as long ago as 1726 beside York Buildings, Strand. Known as the "York Buildings" engine, it was the first reciprocating steam engine installed for public water supply and the boiler feed water, hitherto drawn from the luke-warm piston-sealing water, appears to have been taken from the hot condensate.

Necessity is ever the mother of invention and Mr. Brett-Littlechild shows how the development of highly turbo-charged four-stroke engines has influenced exhaust

*The metre now equals 1,650,763.73 vacuum wavelengths of the orange radiation from the krypton atom of mass 86.

mass flow and its temperature. In a series of twelve diagrams in his paper the layout for varying requirements are set forth in respect of latent heat cooling and heat exchanger cooling respectively. The author does not omit to draw attention to the need for vigilance at the planning stage and particularly to be noted are his suggestions relating to various steps in the heating of high viscosity residual oil. Due reference is made to those other services which provide incentives to plan for the utilisation of the available heat. Among the services mentioned are space heating, process work, supply of additional power, main boiler feed heating, sea-water distillation, refrigerating plant, sewage plant and the use of electrode boilers. With commendable frankness the author has remarked that in certain installations there may be little or no scope for waste heat utilisation. He stresses the advantages anticipated from the use of latent heat cooling in engines burning residual fuels containing sulphur, where the effects of sulphuric acid on cylinder liner wear and on lubricating oil contamination must be considered and all precautions taken to prevent them. On this Mr. Brett-Littlechild claims that with the use of latent heat cooling "condensation and the consequent formation of sulphuric acid is prevented, thus limiting the wear rates on liners, pistons and rings to those experienced with distillate fuel oils."

Speaking not long since on the subject of current automotive development in the U.S.A., Mr. Victor G. Raviolo, of the Ford Motor Company, Dearborn, Michigan, remarked that "Improved reliability, durability and safety, as well as lower initial and operating costs, will continue to be the common goal." He went on to say that "the increasing cost of service justifies additional cost in 'the original build'." This is certainly a factor applying also to such installations as those described in Mr. Brett-Littlechild's paper and we note that in one typical application a pressure-charged engine of 735 b.h.p. has been equipped for waste heat recovery combined with latent heat cooling, provision being made in the engine design for operation on heavy Bunker "C" fuel having a viscosity of 3500 seconds Redwood No. 1 at 100 deg. Fah. It is to be noted that included in this particular lay-out are two converted Lancashire boilers used for thermal storage purposes. This is certainly a bold effort to achieve maximum heat recovery and the author mentions that "to-date, a total of 27,500 b.h.p. British built engines are installed or on order, operating on latent heat cooling, at sites all over the world, and the majority of these engines are operating on some type of residual fuel oil of viscosity over 200 seconds Redwood No. 1 at 100 deg Fah." Engine users will be glad to learn, in due course, something about the operating and servicing experience obtained with these installations. Of special interest would be information relating to the approximate load variations and the frequency of the cold starts.

ELECTRICAL PLANT MANUFACTURE IN INDIA

The factory of Heavy Electricals Ltd., Bhopal, which was formally opened on November 6 by Mr. Nehru, the Prime Minister of India, is surely destined to play an important part in India's industrial development. From the report published on page 845 of this issue it will be seen that, although Heavy Electricals is yet in its infancy as a manufacturing organisation, it has made an auspicious start. Already transformers and switchgear are being made there and their production should be on an appreciable scale by the end of the year. Later, as the factory embarks on heavy fabrication, it will build water-turbines, alternators, electric motors and equipment for railway electrification — and water power, it will be appreciated, is a prerequisite of any expansion in India's economy. By 1964-65 it is expected that the factory will be producing heavy electrical plant worth about £20,000,000 a year and ultimately it is hoped to double this figure and thereby supply the bulk of the country's needs in this field.

The Bhopal factory is by no means the first to make electrical equipment in India, but it is different from the others in that it is Indian-owned. The idea, first conceived in the late 1940's began to take definite shape towards the end of 1955, when Associated Electrical Industries, Ltd., London, was appointed technical consultant and was commissioned to draw up a detailed project report. Since 1957, when the report was accepted by the Central Government of India, collaboration between A.E.I. and the Government has been close and continuous and the scheme has gone ahead, with the help of loans made by a consortium of British banks. In its dual rôle of technical consultant and purchasing agent on behalf of the Indian Government A.E.I. has been largely responsible for advice, planning, and procurement of plant and machinery. What is, perhaps, even more important is that the British company has taken a prominent part in the training of artisans and junior engineers in Bhopal and in arranging comprehensive training programmes for more experienced Indian engineers in A.E.I. works in Great Britain.

We have said enough to suggest that what iron and steel means to Durgapore, electrical plant will, presently, mean to Bhopal. Here is an Indian owned factory, built by Indians with the help of British technical experience and resources and designed to help India to become self-supporting in those very items of heavy electrical plant that would otherwise have to be imported. Here, indeed, is a forward-looking concept of relationships between countries that have reached different levels of industrial development!

The Engineer—100 Years Ago (NOVEMBER 16, 1860)

"WATER GAS AT NARBONNE, FRANCE."

"The gas is made without retorts. The decomposition of water-steam into gas is effected by passing the steam over a mass of burning coke in a close furnace, and the more rapidly this is done the more effective and economical is the process. The oxygen and hydrogen of the steam are, of course, separated, and the oxygen forms with the carbon of the coke carbonic acid gas, leaving the hydrogen unattached even to carbon, so that the water gas is pure or mere hydrogen. The carbonic acid is withdrawn by means of damp quicklime, which, however, rapidly accumulates in quantity; and it is proposed to use carbonate of soda instead, as the carbonate of soda will unite with the carbonic acid and form bi-carbonate, from which moderate heat will again expel all the gas adsorbed, so that the carbonate of soda, it is calculated, may be used over and over again indefinitely.

"Could not the carbonic acid also be made use of as in the production of aerated drinks? Bi-carbonate of soda itself, too, is of some value. One chief peculiarity in the water gas is the mode of burning it. Hydrogen yields a very weak light of itself, but each burner is supplied with the well-known contrivance of a small wirework of platinum, which, by adequate pressure on the main, becomes white hot, and produces an intense light with the hydrogen, without wasting the rather expensive platinum."

Hawthorn Combined Mine

Under a combined mine scheme approaching completion in the Durham Division No. 2 Area of the National Coal Board, the Murton, Eppleton and Elemore collieries have been connected by an underground locomotive haulage system by which all the coal produced is delivered for raising at a new shaft. This scheme has extended by some sixty years the economic lives of the three old collieries which, with extensive modernisation and mechanisation, have a planned combined annual output of 1,600,000 tons of coal. New washing and carbonisation plants have been built adjoining the new Hawthorn shaft as part of the project to treat the combined output of the mines.

A PROJECT of particular interest carried out by the Durham Division No. 2 Area of the National Coal Board is the Hawthorn combined mine scheme which is now approaching completion. Under this scheme a new shaft has been sunk at Hawthorn and connected by an underground locomotive haulage system at two levels, 1100ft and 1400ft deep respectively, with the workings at Murton, Eppleton and Elemore collieries. By these haulage systems the whole of the output of the three collieries is delivered for raising at the Hawthorn shaft, at the head of of which there have been built new coal preparation and coking plants. (This coking plant was described in detail in THE ENGINEER of September 4, 1959).

Each of three collieries involved in the scheme is well over 100 years old, Murton having been sunk in 1838, Eppleton in 1825 and Elemore in 1825, and for many years their respective outputs have been of the order of 3000 tons, 1500 tons to 2000 tons, and 1250 tons of saleable coal a day. At each of the collieries there still remains a considerable amount of coking, steam and industrial coal of good quality. The linking up of the three mines under the scheme has not been effected with a view to increasing their output but to make possible more efficient production and effect the economic survival of the three ageing pits, each of which was burdened with deteriorating, out-of-date plant and working coal reserves far from shafts at the end of old roadways. Further, none of the pits had preparation plant to effect the cleaning necessary to meet modern requirements in view of the seams being worked.

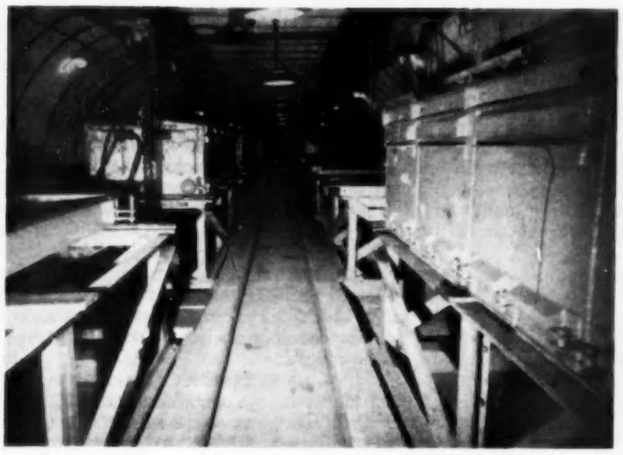
When the scheme is fully operative 8000 tons of coal will be raised daily at the Hawthorn shaft and the known coal reserves will last at this rate for some sixty years. Apart from the main coal transport and winding system, each of the pits will continue to work as a separate unit with its own administration and winding facilities for men and materials, supplies, and stone disposal. To ensure efficient operation, each pit has been extensively modernised with new winding equipment and surface buildings. Underground, each pit is now fully equipped for mechanical coal cutting and handling.

The new 1500ft deep, 22ft diameter Hawthorn shaft is concrete lined and its sinking, which was started in 1952, was completed in 1958. On this site Permian water-bearing magnesium limestone and yellow sands extend from a depth of 276ft below the surface for a thickness of 131ft. When a point some 26ft above the top of the Permian formation was reached in course of sinking the shaft, the diameter was extended to provide a large working chamber. From this chamber a ring of holes was bored down through the water-bearing strata and sands to enable the area to be frozen in the conventional manner for further sinking of the main shaft. This procedure was followed to avoid freezing of the ground near the surface and any possibility of affecting the foundations of the permanent reinforced concrete head-gear structure which was put up initially and used for shaft-sinking purposes. The freezing chamber was subsequently filled with concrete when the shaft walling was lined up.

For the transport of coal underground some 17 miles of new steel arch-lined roadways have been constructed and about 24 miles of 2ft gauge rail track laid between the workings of the satellite mines and the Hawthorn shaft. From the Murton and Eppleton workings the coal is hauled in trains of twenty-four, 2-ton Allen mine cars by 64 h.p. English Electric battery locomotives operated in tandem over certain sections to ensure effective braking. From the Elemore mine the trains are handled over gradients varying up to 1 in 30 by 100 h.p. Huwood-Hudswell diesel locomotives, to a transfer point where the trains are taken over by the electric battery locomotives. In addition to the coal trains, the locomotives also handle the stone trains to the service shafts at the three collieries, as well as the haulage of materials and man-riding trains.

In laying out the haulage system particular care was taken in the positioning of the single and double tracks to ensure a smooth flow of traffic so that, whilst giving a good measure of flexibility, need for shunting operations was reduced to a minimum. The rolling stock is maintained in underground workshops, and battery charging stations (such as that shown in our illustration) have been installed at strategic points throughout the system, three stations being on the upper level and six on the lower level. The Crompton Parkinson traction batteries of 405Ah capacity, which are used on many of the locomotives, weigh some 5 tons each and are divided into four sections bolted together on a sub-frame. To facilitate removal of the batteries for recharging purposes the case of each is fitted with four rollers which run on strips placed across the locomotive frame. At the charging stations the locomotives are driven between two banks of charging racks and as one battery is rolled off the chassis for charging its replacement is rolled on from the other side.

The haulage system is divided into sections controlled by colour light signals arranged to admit only one train at a time into a section, and a colour signal with a diagram of the section of track ahead is mounted on the tunnel wall at driver's level at the end of each section. All signals automatically reset at red and when the driver of an approaching train stops he can, by leaning out of his cab, depress the appropriate push button of the route he wishes to take on the diagram. If the section selected is unoccupied all the



Battery locomotive garage and charging station

Signal and driver's route selection panel at track side

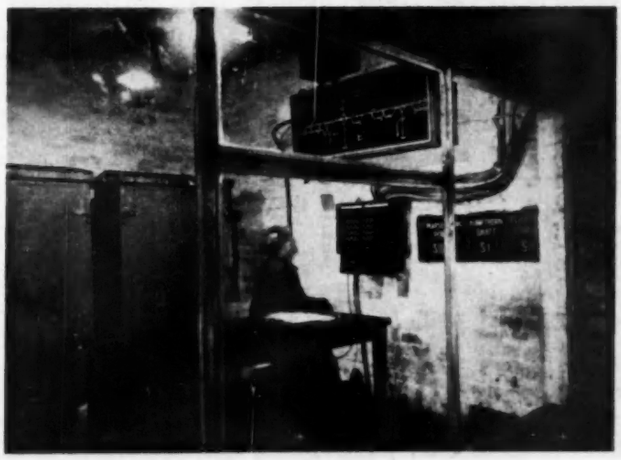
power operated track points are automatically set for the route and the green signal then lights. Immediately the train enters the selected route the signal reverts to danger. At the approaches to the Hawthorn shaft on both levels there are despatcher's cabins equipped with mimic diagrams of the tracks in the vicinity so that the man in charge can check at a glance all train movements. From these cabins, one of which we illustrate, the despatchers route the outgoing empty trains to the various mine districts as required. In addition to there being direct telephone communication between the loading stations in all districts and this cabin, telephones at all signal points throughout the system provide means of immediate communication between drivers and the despatcher in charge of train movements.

Trains of full mine cars arriving at the Hawthorn shaft are hauled past a control and weighing cabin into sidings where they are back-shunted on to a line of marshalling creepers and their locomotives uncoupled. The locomotives are driven round a loop leading back to marshalling lines for trains of emptied cars. The marshalling creepers propel the trains of full cars in turn up a slight gradient to a point ahead of a weighbridge where their further movement is taken over by a creeper controller. Through this creeper controller, train movement is integrated with the operation of the weighbridge and the car tippler beyond. The equipment moves a train forward in steps under automatic control to place cars in pairs, without uncoupling, on to the weighbridge and then on to the tippler. The weighing system is arranged to subtract automatically the tare weight of the mine cars and their contents weight is recorded on a machine in the control cabin. Beyond the tippler the trains of empty cars are marshalled to be hauled back to the loading points as required by locomotives driven back along the return loop from the ingoing track.

From the tippler the coal passes on to a " Sherwen " vibratory feeder delivering on to a belt conveyor feeding skip measuring pockets suspended on batch weighers. In these pockets the coal is weighed in 8-ton batches and as one pocket is full the flow of coal is automatically diverted into the other. When both pockets are full the feeder conveyor is automatically stopped. The measuring pockets load the coal into the winding skips and are arranged to discharge their contents automatically into the appropriate skip when it comes into line. As each skip arrives at the surface its guillotine door is lifted automatically to discharge the coal when it is in line with the chute of a receiving hopper. From the bottom of the receiving hopper the coal is removed at a controlled rate by steel-plate conveyors which discharge on to the main conveyors feeding the washery.

It should be pointed out here that, as the grades of coal raised at Hawthorn are used for carbonisation, industrial and domestic purposes, it is essential that the different grades be segregated into these categories for delivery into the washery. For this purpose an electronic signalling and control system has been installed to monitor each grade of coal through the tippler, winding plant and the conveyors delivering the washery. As each train of full mine cars approaches the weighbridge the attendant in the adjoining cabin depresses the button appropriate to the grade of coal being carried. When the coal arrives at control points leading into the washery its grade is automatically indicated on illuminated display panels.

The coal from each level in the shaft is handled by a separate skip plant and each of the two winding installations, supplied by Associated Electrical Industries, Ltd., works a pair of 8-ton skips to one of the levels. Of these two winding engines the one serving the 1100ft level is driven by a d.c. motor rated at 1100 h.p., 250 r.p.m. ; its 16ft diameter drum has an operating speed of 27·2 r.p.m. The winder for the 1400ft level is driven by a 1500 h.p., 300 r.p.m., d.c. motor and its 16ft diameter drum is driven at 32·6 r.p.m. Each of the installations is operated on the Ward Leonard system with closed loop control via a laminated yoke exciter controlled by flux resetting amplifiers. With a winding time of 76·9 seconds, each winding engine is designed to make up to forty-seven winds an hour to raise some 375 tons of coal in the 8-ton skips. Under the fully automatic cycle speed, current, acceleration, deceleration



Train despatcher's cabin for routing outgoing trains of empty trucks

Train of loaded cars arriving at Hawthorn shaft

and peak power are accurately controlled, switching facilities also being provided for manual control of the winders for raising and lowering men when required. Each winding cycle is initiated when the skip at the surface has been emptied and its door-lifting frame retracted, the skip at the underground level has been loaded, all bridge chutes retracted and the pocket doors closed.

From the pithead receiving hoppers coal is delivered by steel plate conveyors on to two 42in conveyor belts for transport to the new washery. This washery is designed to handle 750 tons of run-of-mine coal an hour; as already mentioned, the grades of coal from the mines are segregated into main categories and with each change in delivery, notice is given to the washery controller allowing him ample time to make the necessary arrangements. The plus 8in coal is removed by two primary screens and delivered on to picking belts for crushing to minus 8in. The whole of the minus 8in product is then delivered to two secondary raw coal screens for separation in to 8in to 1in and 1in to 0. The 8in to 1in coal is then washed in a Chance cone and the 1in to 0 conveyed to one of four 1000-ton capacity bunkers according to its grade. From these bunkers the 1in to 0 coal can be drawn at a rate of 300 tons an hour and, after the $-\frac{1}{16}$in has been screened out, delivered for washing to a second Chance cone. The remaining $-\frac{1}{16}$in fraction is treated in a froth flotation plant. The washery delivers some 1400 tons of $\frac{1}{2}$in to 0 product a day to the blending bunkers of the nearby carbonisation plant. The plus $\frac{1}{2}$in cleaned coal is graded in four sizes—8in to 4in, 4in to 2in, 2in to 1in, and 1in to $\frac{1}{2}$in and delivered from the screens to four rail wagon loading stations. The washed $\frac{1}{2}$in to 0 feeding the carbonisation plant can be readily diverted to rail wagons or road vehicles.

At these wagon loading stations the coal trucks are handled by "wagontrollers" and filled by boom loaders operated by weighmen on a gantry above the loading points; automatic weighing machines being installed to check and record the weight of incoming empty and outgoing loaded trucks.

The consulting civil engineers for this project were the British Reinforced Concrete Engineering Company Ltd.

CONTRACTORS:

Civil engineering work, earthworks and site preparation, Dowsett Engineering Construction Company, Ltd.; shaft, Blandford-Gee Cementation Company, Ltd., and the Foraky Boring and Shaft Sinking Company, Ltd. (first 75ft carried out by Sir Robert MacAlpine and Co., Ltd.); coal preparation plant, General Electric Company, Ltd.; railway, sidings, Thos. W. Ward and Co., Ltd.; winding engines, Associated Electrical Industries, Ltd.; skip plant, Head Wrightson and Co., Ltd.; headgear, Henderson Brothers; underground locomotives, English Electric Company, Ltd., Huwood-Hudswell Company, Ltd.; underground signalling, Westinghouse Brake and Signal Company, Ltd.; mine cars, W. G. Allen and Sons (Tipton), Ltd.; weighbridges, Henry Pooley and Son, Ltd.; wagontrollers, Norton-Tividale, Ltd.; access road, George Wimpey and Co., Ltd.

Milford Haven Oil Refinery

With its Fawley refinery operating at economic maximum output, coupled with the need to expand production to satisfy the increasing demand for oil products, the Esso Petroleum Company, Ltd., decided to build a second refinery. The site chosen was at Milford Haven, where there is adequate depth of water to berth the largest tankers, and on November 3 the refinery, having a throughput of 4,500,000 tons per annum, officially went on stream.

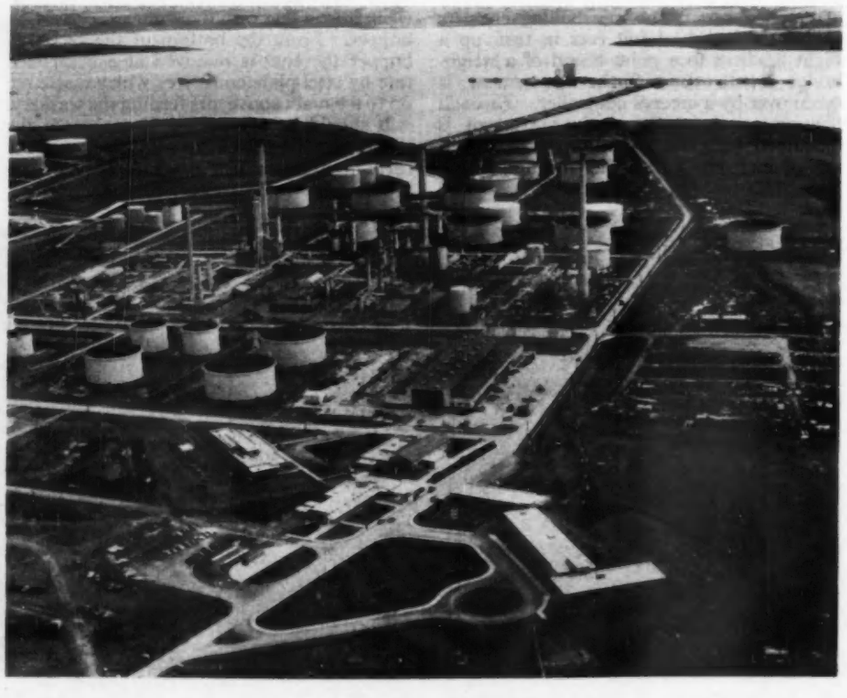
LAST week we gave an overall general review of the new Esso refinery built at Milford Haven and the opening ceremony on Thursday, November 3, and this week we give further particulars of the various process units, some of which we illustrate.

Our illustration gives an aerial view of the refinery, looking south, and serves to indicate the layout of the area. The process units are centrally located and near-by is the large maintenance building with the administration and other offices in the foreground, while in the background are the crude storage tanks, skimming pond and marine terminal. Investigation of the site indicated that there was an overburden of clay and rock fragments and that the bed rock was mainly of old red sandstone, while the ground contours meant that terracing was necessary to take process units and tanks. A hydrographic survey was also made in the jetty area to establish the contour of the sea bed and its composition, together with data relating to the tide cycle. The building of the refinery was broadly divided into four phases: ground clearing and roadmaking; building of the marine terminal and erection of plant and tankage; installation of services; and the final tidying up and landscaping.

Ground clearing and levelling involved the removal of some 600,000 cubic yards of earth, while nearly 8 miles of roads had to be laid and an earth-filled dam having a length of about 225ft had to be built at the seaward end of the valley to form a skimming pond. Construction of the jetty, of which a preliminary account appeared in our issue of October 9, 1959, is in concrete and the superstructure decking, 16ft wide is mainly in precast units supported on pressed hollow piles of either 27½in or 22in outside diameter. The latter were prepared in a casting yard, on the site, in lengths up to 500ft, but divided beforehand into the length actually required for an individual pile, 143ft being the longest used. The jetty head has two ocean berths, each measuring 350ft by 50ft wide, each protected by four 52ft wide fenders, each consisting of eight 36in by 12in universal beams driven as piles and fitted with spring steel and rubber buffers, to assist energy absorption and designed to take the horizontal loading imposed by a tanker of 135,000 tons deadweight approaching at an angle of 10 deg. and a speed of 1 knot. The critical loading factor was, however, the thrust of a 100,000-ton deadweight tanker, when unloaded, under wind loading. A third berth on the shoreward side of the jetty head is for coastal tankers ranging from 300 tons to 5000 tons deadweight, and for securing the ships there are fourteen mooring dolphins equipped with 30-ton, 60-ton and 100-ton bollards. For handling the crude oil and oil products there are hose handling gantries having an overall height of 128ft to allow for draught change of the ship and a tidal movement of 26ft to give an overall range of 78ft. A 36in diameter line carries the crude oil, while the product lines range in diameter from 10in to 20in, those taking heavy oils being steam traced. Crude oil supplies will be supplied from the Persian Gulf and Mediterranean ports in tankers of up to 52,000 tons deadweight, to be joined next year by the first of the company's 77,000-ton deadweight vessels. Distribution of products is mainly by water and tankers of 16,500 tons deadweight supply five ocean terminals, while coastal tankers supply six bulk plants. About twenty-six inland bulk plants are supplied by road and rail facilities.

PROCESS UNITS

From the crude oil storage tanks oil is pumped through heat exchangers before entering the multi-pass oil and gas fired pipe still which has a heat output of 465,000,000 B.Th.U. per hour and where the oil is raised in temperature to about 750 deg. Fah. Our illustrations show the battery of heat exchangers, and the pipe still of the crude distillation unit. At this temperature, 750 deg. Fah., the oil is fed to the 100,000 barrels per stream day atmospheric distillation unit, having a fractionating column 9ft in diameter by 211ft high, to produce five main cuts.



Aerial view of refinery looking south

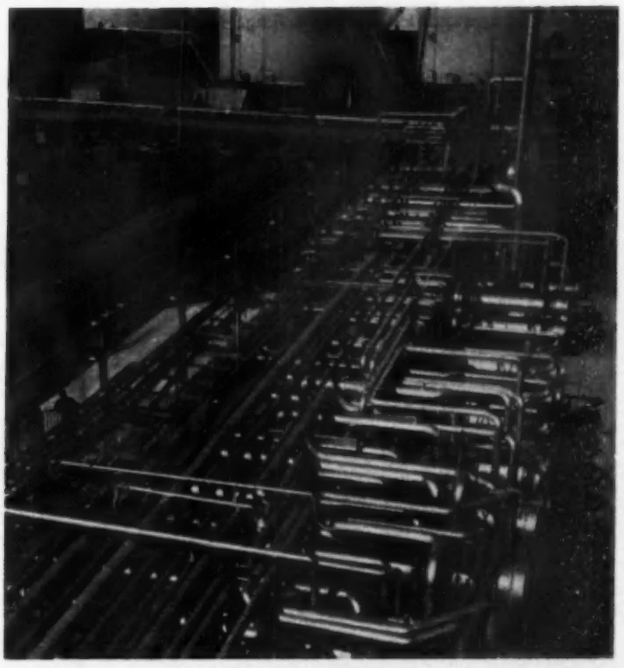
Over the top of the tower passes gas, which is condensed, then the second is jet fuel, the third is gas oil and the fourth is heavy gas oil. All sidestream cuts are steam stripped before being cooled. The condensed light ends enter the naphtha splitter from which the heavy naphtha is pumped to storage as powerformer feed stock, while the splitter overheads pass to a debutaniser tower from which the light gas is fed to the refinery fuel gas main and a mixed propane/butane liquid is forwarded to the depropanising tower on the powerformer. A stabilised stream from the bottom of the debutaniser is passed through the 7800 barrels per stream day copper sweetening unit where it is given a caustic wash, is passed through an electrical coalescer, heated and mixed with air, treated in a copper chloride contactor and then water washed before passing to storage for final blending.

The second cut is kerosene and jet fuels, the jet fuel being treated in the 14,900 barrels per stream day copper sweetening unit. Gas oil is the next cut and this is passed to the hydrofiner which can desulphurise a maximum of 16,500 barrels per stream day. The gas oil is heated in a furnace and mixed with hydrogen-rich gas from the hydrofiner and then passed to a catalytic reactor where the sulphur compounds are converted to hydrogen sulphide. A separator removes the gas which is piped to the refinery main while the gas oil remaining is steam stripped and sent to storage. Heavy gas oil is passed to storage. The bottoms from the fractionating column, after giving heat in the preheat exchangers go to heavy oil storage facilities. The main process units are illustrated overleaf with the distillation unit (left), hydrofiner (centre) and powerformer (right) and banks of air coolers in the foreground.

In the powerformer the low octane number naphtha is processed into high octane motor spirit blending material. The process is a fixed-bed catalytic reforming process using a platinum-coated catalyst and the facility has a capacity of 14,900 barrels per stream day. Naphtha feed stock is first hydrofined to reduce the sulphur content and then, after hydrogen-rich gas, used in the hydrofiner, has been removed in a separator, the feed stock, mixed with hydrogen-rich gas, is heated and passes to the powerformer.

This consists of a number of reactors containing the platinum catalyst and the feed is passed through each. The reaction is endothermic so that the stream has to be reheated before entering the next reactor. In the reactors the molecular structure of the raw petrol is reformed in the presence of hydrogen and both hydrogen and light hydrocarbon gases are formed. The stream from the final reactor is cooled and some gas taken off in a separator and compressed and recycled back to mix with the feed. The liquid from the separator enters a stabiliser and from the top of the tower refinery fuel gas is taken off, while lower down L.P.G. products are drawn off and the stabilised bottom stream, after further treatment, is forwarded as high octane powerformate to blending tanks.

Although the products give up some of their heat in heating the feed stock further cooling is required and in this refinery, instead of using water for this purpose, air cooling has been adopted. Batteries of forced draught " Air Fin " coolers, supplied by Spiro-Gills, Ltd., have been mounted, some of which have variable pitch blades while others have variable speed motors. The adoption of air cooling does mean a considerable saving of water and minimises the risk of pollution while reducing the cost of equipment. Another point of interest is the absence of the usual flare stack which is replaced by a low elevation, non-luminous smokeless flare of multi-jet burner design, which is 60ft high by 50ft diameter, and fed by an 18in overhead line. All process units are automatically controlled which is an essential in the working of the units, since the demand is for high quality products and therefore the refinery has to operate between critical limits. The main variables, flow rates, pressures, temperatures and gauging are all recorded and maintained automatically, the equipment including Honeywell multipoint electric strip chart recorders and miniature instrumentation by Taylor Controls, Ltd., and Minilarm panels. Many of the valves employed are electrically actuated " Audco " units, while others are Fisher automatic valves, including an in line blending unit. The layout of the control room can be seen in our illustration.



Pipeband and heat exchanger train on the crude distillation unit

Tankage and Services

Where storage tank foundations were constructed on fill the material was compacted to nearly unit density in order to minimise

Pipestill furnace with heat output of 465,000,000 B.Th.U per hour, crude distillation column on right

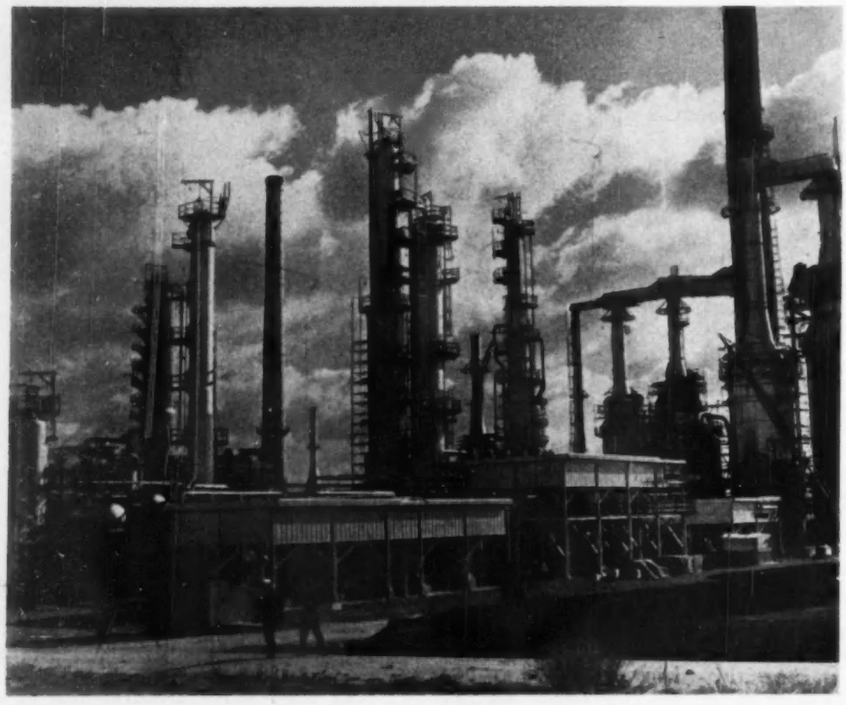
any settlement taking place. Ground bearing loading adopted ranged from 2·0 tons to 5 tons per square foot according to type of overburden. For crude oil storage there are nine floating roof tanks, each of 150ft diameter by 54ft high and fitted with side entry mixers. Total capacity is about 1,500,000 barrels or two weeks' supply. The tanks are not contained within bunds for, due to ground slope, any leakage is drained to the skimming pond. Intermediate storage and product storage tanks are 42ft to 48ft high and vary in diameter from 56ft to 150ft. Nine of the tanks are steam heated, but those containing high viscosity oil have been insulated with "Eldorite" mineral wool slabs with an exterior cladding of corrugated aluminium sheet. The deisopentaniser tower is similarly insulated and the same material has been used for the insulation of pipework and ducting. Sixty-five out of a total of sixty-nine tanks are fitted with Whessoe S. and J. Telepulse system, giving remote indication of liquid levels and temperatures, and our illustration is of a Whessoe/Fielden servo tank gauge with Telepulse transmitter. Two 52ft diameter spheres operating at a working pressure of 65 lb per square inch store a total of 26,000 barrels and in addition there are two spheres of 36ft diameter and seven horizontal drums of 10ft diameter by 110ft long. The total capacity of the oil refinery tankage is 190,000,000 gallons. Utility tanks are provided for raw water, water for fire fighting, and ballast water.

Particular care has been taken to ensure a clear effluent; process and storm water from the northern section passes through a separator and the water is passed to the skimming pond which has a capacity of 10,000,000 gallons and is fitted with a skimming device to ensure a clear effluent. This is discharged into the Haven through a 48in line. Ballast water from oil tankers is pumped to two ballast water tanks where the oil is allowed to settle and afterwards pumped to slop tanks, while the water is passed to the skimming pond. Another precaution to prevent pollution of the sea due to spillage from a tanker while unloading or loading is the use of a 16in diameter inflatable floating boom to which is attached a 2ft skirt. This surrounds the tanker and contains any spillage which is recovered by a separator barge and discharged to shore tanks. To avoid smell from refinery gases and to ensure their adequate dispersal the three main stacks are 300ft high.

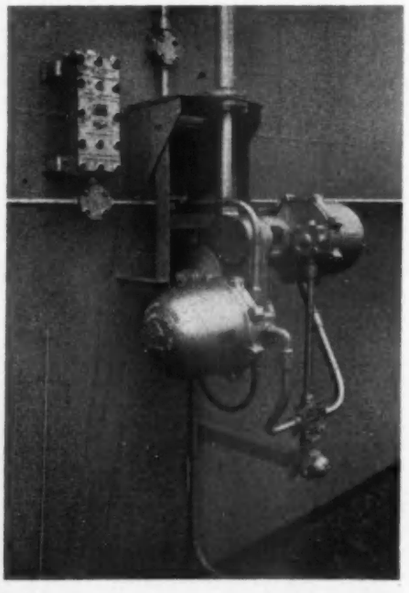
Steam is provided for process and services by two Foster Wheeler two drum, natural circulation, oil and gas fired boilers, each having an evaporation of 130,000 lb of steam per hour at 160 lb per square inch gauge and 450 deg. Fah. For raw water supplies a 5,000,000-gallon capacity reservoir has been built and is supplied from the Western Cleddau River. A 20in diameter pipeline feeds the refinery, while a 6in diameter main supplies potable water. The refinery's electrical power requirement amounts to about 100 million kilowatt hours per annum and is provided from the national grid through two separate and independent 132kV, three-phase, 50 c/s feeder systems. Distribution within the refinery is at 11kV, 3·3kV and 440V.

Three motor-driven and one turbine-driven Alley and MacLellan compressors provide air at 125 lb per square inch gauge. For refinery maintenance services there is a building 340ft long by 140ft wide, including a 100ft wide centre bay, which was built by Rubery Owen and Co., Ltd., and houses a machine shop, an electrical shop, shops for welding, mechanical fitting, carpentry and painting and for instrument repair. A laboratory maintains a twenty-four hour watch over quality control requirements.

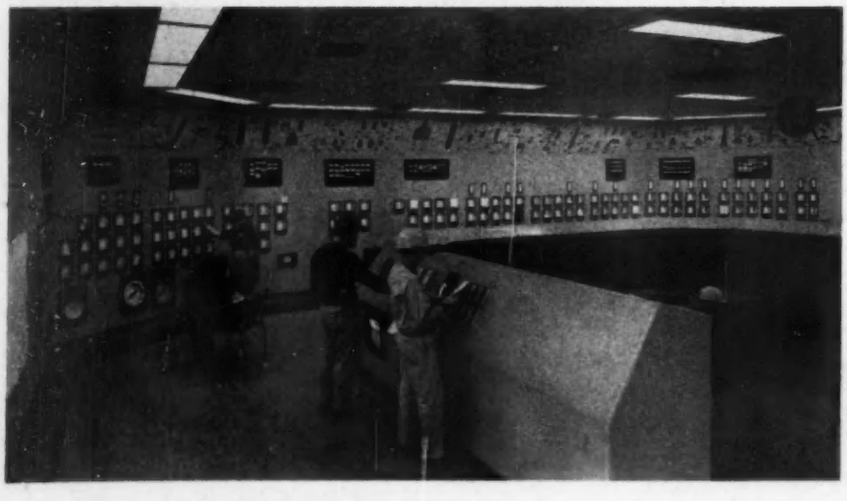
Mr. Colwyn Foulkes was responsible for the landscape work, while the architects were Sir Percy Thomas and Son.



Process units with crude distillation unit (left), hydrofiner (centre) and powerformer unit (right) with air coolers in foreground



Servo-tank gauge with Telepulse transmitter



Process units control room

Turbo-Electric Propulsion of S.S. "Canberra"

The turbo-electric propulsion system for the P. and O. passenger liner "Canberra," 45,000 tons gross, is described in this article, which is based on a paper given by L. W. W. Graham, B.Sc. (A.E.I. Heavy Plant Division), to the A.E.I. Summer School, 1960, for professors of electrical engineering. Each of the two screws is driven by a double unit synchronous motor. The power is supplied by two turbo-alternators. Normally each turbo-alternator supplies the two motors on one shaft and the total output is 85,000 s.h.p. For cruising one turbo-alternator can be shut down and the other set connected to supply the motors driving both shafts at powers up to 40,000 s.h.p. There is provision of synchronising the propellers electrically, as described below, with a view to reducing vibration caused by propeller beat.

THE steamship "Canberra" is a 45,000 tons gross, twin-screw, passenger liner being built by Harland and Wolff, Ltd., Belfast, for the P. & O. Steam Navigation Company. She was launched on March 16, 1960, and will have the most powerful turbo-electric propulsion machinery installed in this country.

Brief particulars of S.S. "Canberra"

Overall length	820ft
Beam	102ft
Maximum load draft	32ft 6in
Gross tonnage	45,000
Passengers	550 First Class 1685 Tourist Class
Crew	1000 approximately
Cargo capacity	150,000 cubic feet
Service speed	27½ knots
Maximum propulsion power	85,000 s.h.p. at 147 r.p.m.
Normal service power	68,000 s.h.p. at 137·5 r.p.m.

Operation will be in conjunction with the geared-turbine "Oriana" of 40,000 tons gross being built for the Orient Line. It is intended with these two ships to extend Australian voyages across the Pacific to the West Coast of North America. Apart from being the largest passenger liner to serve these routes, the "Canberra" is the largest passenger liner being built in Great Britain since the "Queen Elizabeth," and will be the first British passenger liner to have all auxiliaries powered by alternating current. The turbo-electric propulsion machinery is being supplied by Associated Electrical Industries, Ltd.

In the "Canberra" the engine-rooms are placed well aft to allow the maximum scope in the layout of public rooms. The choice of turbo-electric drive enabled the owners to make the most of the aft siting of the propulsion machinery; the motors could be placed well aft to reduce shaft lengths and the turbines could be positioned independently, with the boilers mounted above the propeller motors to reduce the steam pipework runs. Operational flexibility is an important advantage of this drive; for economical cruising both propeller motors can be supplied with power from one turbo-alternator set (the other set being shut down) as explained below.

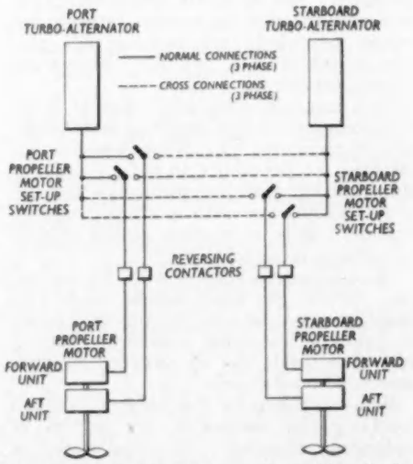


Fig. 1—Simplified key diagram of propulsion circuits

Turbo-Electric Drive

The propulsion system adopted for the "Canberra" is a refinement of the basic turbo-electric drive in which a propulsion turbo-alternator powers a synchronous propeller motor direct-coupled to the propeller shafting. The ratio of the number of poles chosen for the alternator, usually two, and the number chosen for the propeller motor determines the speed reduction between turbine and propeller. This reduction permits optimum turbine as well as optimum propeller speeds. With the turbine running at 25 per cent full speed light, the propeller motor stator is connected by contactors, for ahead or astern rotation, to the alternator stator. The alternator is then excited, usually with a boost value of excitation, and the motor is started as an induction motor, a squirrel-cage winding being embedded in the rotor pole faces.

When the motor is approaching synchronous speed, i.e. 25 per cent of full speed, its field is excited to bring the motor into step. Both alternator and propeller motor excitations are reduced to the normal operating values, and any propeller speed between dead slow and full speed is obtained by controlling the turbine speed.

The "Canberra" is twin-screw and Fig. 1 shows the basic circuits available for supplying the two propeller motors from one or both of the two propulsion turbo-alternator sets. Each motor is of double-unit construction, that is, there are two separate motors within a common frame and on a common shaft. Switchgear allows any one or more motor units to be connected to either of the turbo-alternators, i.e. the two alternators cannot be paralleled.

Apart from emergency running arrangements, the normal operating combinations available are as follows:—

(1) Port turbo-alternator supplying the two port motor units and, independently, the starboard turbo-alternator supplying the two starboard motor units, up to 85,000 s.h.p.

(2) One turbo-alternator set completely shut down, and the other set supplying both propeller motors at powers up to 40,000 s.h.p. This arrangement allows economical running at reduced powers, should the "Canberra" ever be required for cruising.

(3) Port and starboard propellers synchronised. This condition is attained by the port alternator powering the forward port and starboard propeller motor units, and the starboard alternator powering the aft propeller motor units.

Synchronising of propellers is concerned with the problem of hull vibration due to propeller beat. During sea trials investigations will be carried out to determine if synchronising the propellers with any particular blade relationship, e.g. in-phase, anti-phase, &c., further improves smooth running under specified loading and speed conditions.

Reversing the direction of rotation of a propeller motor is effected by interchanging two phases. The reversing contactors are operated with the propulsion circuit "dead" and are, in effect, set-up switches.

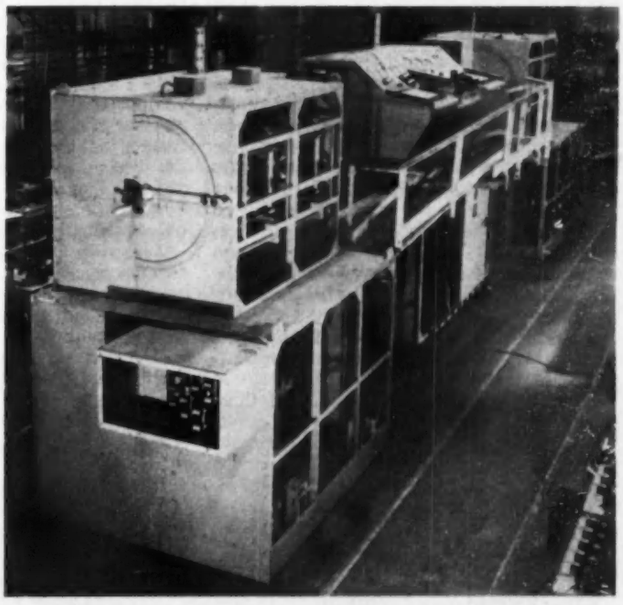


Fig. 2—Propulsion control gear in Rugby works. The console and excitation cubicle are in the centre. Outboard are the h.t. set-up switch and contactor cubicles

Propulsion Control Gear

The arrangement of the propulsion control gear in the factory for test purposes, shown in Fig. 2, gives an indication of the layout in the ship except that, when the outboard cubicles are installed they will be below the turbine platform level on which will appear only the console and lever gear. In the centre

of Fig. 2 is the console and below it the excitation cubicle. Outboard are pairs of cubicles containing all the h.t. equipment. In each pair, one being associated with each drive, the upper cubicle contains the propulsion set-up switches, and the lower cubicle the reversing contactors. This propulsion control gear is placed forward of the propulsion turbo-alternator sets and the operator at the lever gear, Fig. 3, faces aft.

Console.—On the console behind the propulsion levers are horizontal edgewise tachometers in pairs indicating the associated turbo-alternator and propeller motor speeds. " Cirscale " instruments indicate propulsion a.c. voltages and currents, shaft horse power, exciter d.c. voltages and currents, the actual movement of each propeller and a count of its revolutions, using selsyn drives, the relative movement of the two propellers, using a differential selsyn, and rudder angle.

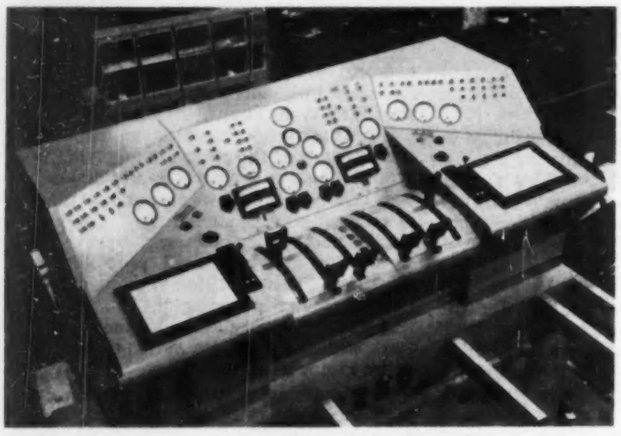


Fig. 3—Propulsion console, showing the twin-screw lever gear and instrumentation

Lamps indicate the switching of propulsion and excitation circuits, faults, excessive machine temperatures, essential auxiliaries operating, and whether propeller turning gear is engaged.

At each end of the console there are : (a) a " short-circuit " relay which trips excitation in the event of a heavy overcurrent in the propulsion circuit, a temperature indicator connected to thermocouples in the alternator and propeller motor stators and ventilating systems, and an alternator output kilowatt-hour meter.

Lever Gear.—There are two sets of three propulsion levers, one set for each drive. From outboard to inboard, each set comprises a direction lever, a speed lever, and a starting lever. The direction lever is mechanically coupled to the reversing contactors, and closes them for ahead or astern operation.

The starting lever is concerned only with applying alternator and propeller motor excitations. At its first position, boost excitation is applied only to the alternator which, during starting, is driven by the turbine governed at a quarter full speed, and the motor runs up nearly to its synchronous speed as an induction motor. At the second position, reduced boost excitation is applied to the motor as well as to the alternator, and the motor is synchronised. The final position of the lever reduces alternator and motor excitations to the normal values for continuous running.

The speed lever is mechanically coupled to the associated turbine governor control system. For fine adjustment, this lever has a worm which engages with a rack. Increasing steam flow can be obtained only by adjusting this worm, above the quarter-speed position of the lever, but the worm can be disengaged for reducing the steam flow.

Lever interlocking is provided to guard against maloperation. Further interlocking ensures that the propulsion and excitation circuit set-up switches cannot be reset, or access gained to the h.t. or excitation cubicles, unless the direction and starting levers are in their " off " positions.

Outboard of the direction levers are the telegraph reply actuators, and outboard of each of these actuators is a desk giving access to a sub-standard kilowatt meter, which provides accurately the alternator power output for trials purposes.

Propulsion set-up switches.—Each h.t. set-up switch cubicle, contains two groups of three switches, one group for each half of the associated propeller motor. These switches have three positions :—" starboard alternator," " off " and " port alternator." They are operated manually, the operating arms carrying the mechanical interlocking which ensures that they can only be reswitched when the direction and starting levers are " off," and that these levers can only be moved from " off," when the switches are positively in one of their three positions.

Reversing Contactors.—Below each set-up switch cubicle is the associated h.t. reversing contactor cubicle, containing two groups of four contactors, which determine the direction of rotation of the associated propeller motor, and are mechanically closed in pairs, for " ahead " or " astern," by the direction lever.

Full power conditions carried by each contactor, Fig. 4, are 6000V, 1550A, but interlocking of the lever gear ensures that no contactor can be opened unless excitation has already been removed from the alternator and propeller motor. To obtain a rapid decrease in excitation the automatic control units incorporate a voltage suppression circuit which operates when the starting lever is brought to the " off " position. The reversing contactors will, therefore, not be called upon to open on load. This voltage suppression circuit is also initiated by the " short circuit " relay which trips excitation in the event of a heavy overcurrent due to a fault in the propulsion a.c. system.

Exciter Set-up Switches.—Below the control console is slung the excitation cubicle which contains the relatively low-voltage control gear including excitation switchgear and contactors.

The propulsion exciters are driven in tandem with the auxiliary turbo-alternators ; each of the four auxiliary turbo-alternator/propulsion exciter sets comprises a pass-out turbine with combined condenser, 6000/1200 r.p.m. reduction gearing, a 1500kW normal rated, 0·8 p.f., 440V, three-phase, 60 c/s alternator, a tandem driven 300kW, 300V, 1000A d.c. continuously rated 1200 r.p.m. propulsion main exciter and a " V "-belt-driven 1800 r.p.m. exciter set, including the pilot exciter for the propulsion main exciter and also the main exciter and small permanent magnet alternator for the auxiliary 1500kW alternator. The commutators of the propulsion main exciters are of Pollock construction, and are excluded from the closed air circuit.

Set-up switches in the excitation cubicle, enable one propulsion main exciter to be connected to the port excitation busbars and another to the starboard busbars. Two exciters are standby.

Excitation Control Units.—Built into the excitation cubicle are four " Magnestat " excitation control units, two associated with each drive. Of the two, one is normally working, but automatic changeover is provided to transfer control to the second regulator in the event of failure of the first. If the second regulator fails control is transferred automatically to " hand." In the event of such a transfer to hand, maximum excitation is applied but this can be reduced by the operator to the value appropriate to the power. The regulators control excitation on a volts-per-cycle basis when the propeller motors have been synchronised, but give fixed values of boost excitation during the starting sequence.

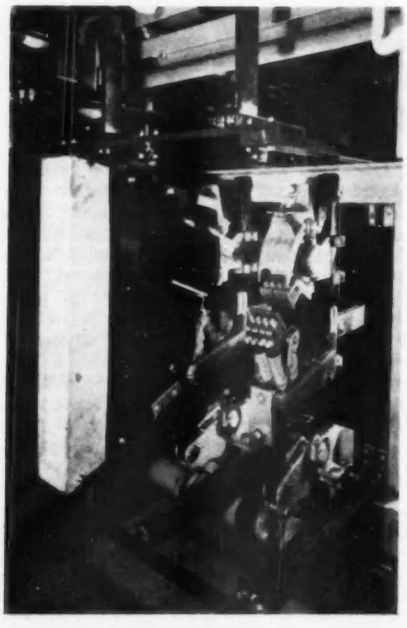


Fig. 4—Reversing contactor with arc chute removed

Each regulator comprises a voltage sensitive circuit and a two-stage magnetic amplifier. It excites the pilot exciter which serves the main exciter which, in turn, serves the alternator and propeller motor. It is because of the resulting combination of time constants that the voltage suppression circuit referred to earlier is required.

Field Set-up Switches.—With the switchgear in the excitation cubicle, each half propeller-motor field can be connected either to port or starboard excitation busbars. Alternator fields can be switched to their associated busbars only.

When setting-up for any running condition involving two alternators, the pattern of connecting alternator and motor stators is repeated when connecting their fields to the

propulsion exciters, so that there are at all times two completely independent electrical systems. Consequently, if a fault were to develop in one system, it could not affect the other.

Referring to Fig. 1, if the port alternator is supplying both port propeller motor halves, the three fields are connected to the port excitation busbars and are, therefore, excited by the same machine. The starboard alternator and propeller motor fields are connected to the starboard excitation busbars, and supplied by a second exciter.

Similarly, when the propellers are synchronised, the port alternator and two forward propeller motor fields are connected to the port excitation busbars, and the starboard alternator and two aft propeller motor fields to the starboard excitation busbars.

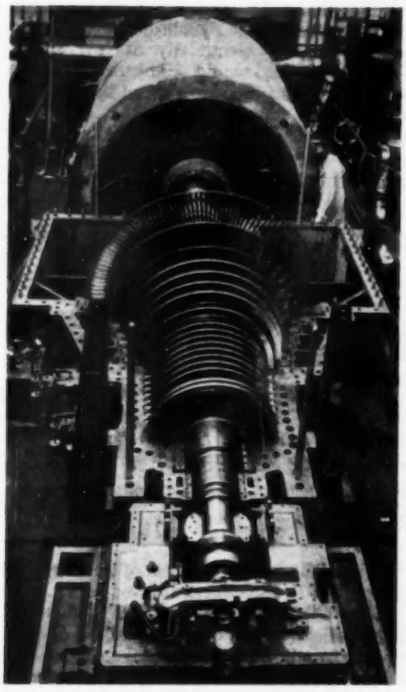


Fig. 5—Starboard propulsion turbo-alternator set during erection in the Rugby works

However, under the cruising condition of one alternator powering both propeller motors, the alternator field is supplied by one exciter and the four motor fields by a second exciter.

Propulsion Turbo-Alternator Sets

Each propulsion turbo-alternator set (Fig. 5) is rated 32,200kVA, 1·0 p.f., 6000V, three-phase, 51·5 c/s, 3100A, 3087 r.p.m., equivalent to 85,000 s.h.p. on two sets ; and 30,700kVA, 1·0 p.f., 4670V, three-phase, 40 c/s, 3800A, 2400 r.p.m., when powering both propeller motors at 40,000 s.h.p. The cruising power, therefore, determined the alternator size.

Developed from a land machine, supplied for power stations where fuel economy and reliability are of the greatest importance, each single cylinder turbine has seventeen stages and cam-operated multi-valve control. Steam conditions are 700 lb per square inch gauge 950 deg. Fah., the vacuum corresponding to the service power being 28½-in Hg.

A fundamental change from the land design lay in suiting the machine to variable speed operation, particularly in terms of blade vibration. Vibration characteristics of individual blades were calculated in the design stage and checked, initially by single blade tests, where necessary with bladed segments, and finally in the completed rotor. Another departure was the provision of twin governors, one to control the turbine speed at 25 per cent full speed during manoeuvring, when the propeller motor is brought up to this speed during starting, and the other adjustable between about 85 per cent full speed and above the running speed when it is available as a pre-emergency governor to catch the set before it trips out on overspeed.

In common with large land turbines, supervisory gear is provided. This indicates and records differential expansion between rotor and stator, eccentricity of rotor, and vibration at any one of the four turbine and alternator bearing housings. This information is particularly important during starting up and shutting down.

In design the alternator varies very little from land practice for a two-pole cylindrical rotor machine. A higher short-circuit ratio, of the order of 1·2 against 0·5, is adopted so that the alternator is a " stiffer " machine and more able to cope with load swings at sea. Fans on the alternator rotor circulate ventilating air, in a closed system, through sea-water-cooled air coolers contained in an air chamber below the machine. The alternator neutral is permanently earthed through a high resistance located in the air chamber.

All turbine and alternator bearings are forced lubricated by motor-driven pumps. A bellows coupling connects the turbine and alternator rotors.

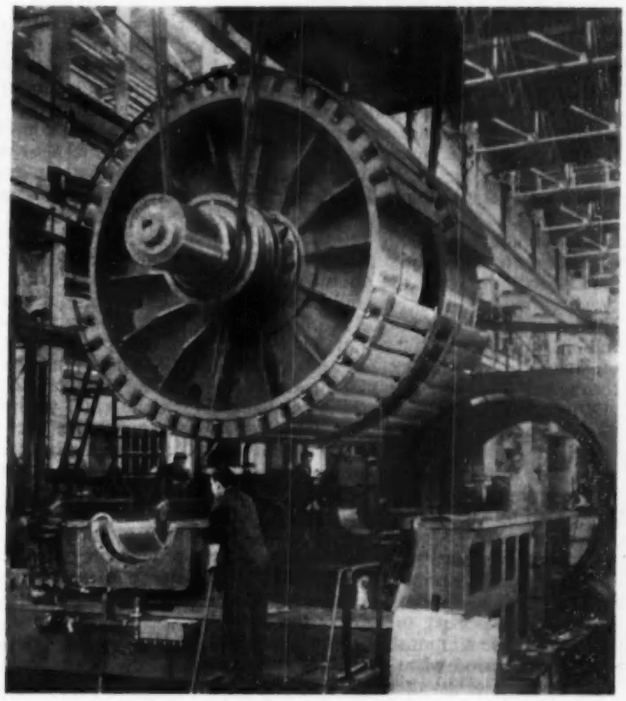


Fig. 6—Port propeller motor rotor being lowered into bottom half stator. Poles on the horizontal joint have been removed to provide access for reconnecting the stator winding when the top half stator is in position. The starboard stator is in the background

Propulsion Motors

Each forty-two-pole synchronous propeller motor has a closed air circuit and is rated 42,500 s.h.p., 6000V, three-phase, 51·5 c/s at 147 r.p.m. on two units.

Referring to Fig. 6, a fabricated drum

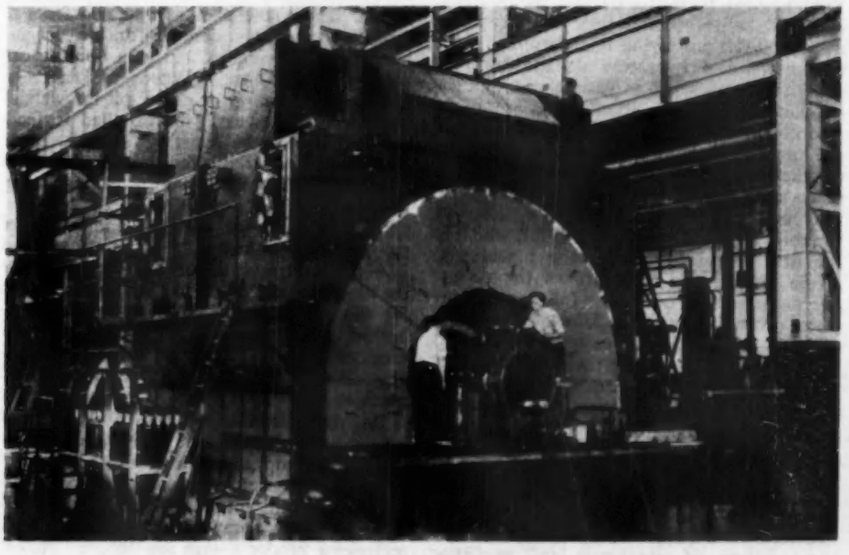


Fig. 7—Starboard propeller motor erected for test in Rugby Works

carries the two spiders to which are bolted the rotor poles. The drum is supported between forged steel stub shafts. Embedded in the faces of the rotor poles, are the squirrel-cage bars. The field coils are strip-on-edge wound. During the starting period when the propeller motor is operating as a squirrel-cage induction motor, its field is switched across a resistance mounted in the air trunking.

The induction pull-out torque on boost excitation during starting is 67 per cent full-load torque. When the motor has been synchronised at quarter full speed, the synchronous pull-out torque is 130 per cent full load torque. At full power, 85,000 s.h.p. on two screws, the synchronous pull-out torque is 200 per cent full load torque.

Whereas, with a geared-turbine installation, the braking power during a reversal is dissipated in the astern turbine, with an a.c. electric drive the braking power is dissipated in the squirrel-cage winding and field circuit, completed by the discharge resistance, of the propeller motor.

Mention has been made of the procedure for synchronising propellers with a view to reducing hull vibration, but before synchronising it is necessary to achieve the correct propeller blade relationship. This is attained during the period when operating as an induction motor by altering the resistances across the fields of one propeller motor to increase its slip. When the propellers are in the correct relationship the motors are excited and synchronised in the usual way.

Fig. 7 shows the ventilating system, which includes motor-driven fans and air coolers (with circulated sea-water), carried on top of the stator frame. Field discharge resistances and the contactors which adjust the resistance values are enclosed in the air trunking.

For ease of transport to the shipyard, the stator frames are split vertically between the forward and aft units. The stators and frames are also split horizontally on the centre line. Both bearings are self-lubricating but have individual motor-driven jacking oil pumps, automatically started for speeds below 30 r.p.m.

Trials

Testing is taken as far as is practicable at each stage of completion, in the factory, at basin trials, and during sea trials. Light runs are carried out in the factory, from which the electrical performance and temperature rises of the turbo-alterators and propeller motors at full power can be determined, and the mechanical operation of the turbine, governors, trips and various auxiliaries checked. Particular attention is given to smooth running at all speeds. All circuits of the propulsion control gear and operation of the lever gear, interlocks, contactors, relays and switches are checked.

When the machinery has been installed in the ship, a basin trial is carried out, which is the first combined test of the machinery. While the electric drive allows the turbo-alternator sets to be run at full speed, propeller revolutions must be limited during this test and the maximum power that can be transmitted is low. Nevertheless, the correct operation of the lever gear, switches, alarm and indicating circuits, trips and auxiliaries can be confirmed.

Testing will be completed during the sea trials which include runs at various powers along a measured mile, consumption trials at various powers, a full power reversal, an astern run, and a demonstration of the various combinations of alternators and propeller motors.

300,000 S.H.P. Proposal

With interest from a number of sources in the building of large Atlantic liners both of the present luxury class and of the envisaged "cafeteria" type, consideration has been given to the contribution that an electric drive can make for very large powers, bearing in mind that the propulsion turbines can be developed from large land machines many of which are already in operation.

One proposal, for 108,000 ton liners, required 300,000 s.h.p. on five screws at 250 r.p.m. With a development of the "Canberra" scheme, two 150,000 s.h.p. propulsion turbo-alternator sets could power the five propeller motors.

During manoeuvring, operation could be be very similar to that of the twin-screw "Canberra" with the port turbo-alternator set powering the port outer and inner propeller motors and the starboard turbo-set powering the starboard outer and inner propeller motors. When under way, the centre screw would be powered, one half motor being connected to the port propulsion system and the other half to the starboard propulsion system. This arrangement would have the advantage of synchronised propellers at sea although, as in the case of the "Canberra," the two electrical systems would be completely independent: a fault in one could not affect the other.

For a five screw arrangement a very compact engine room is again possible as only the propeller motors need be lined out with the shafting. As the propeller speed specified was 250 r.p.m., these 60,000 s.h.p. motors would be smaller than those already described for the "Canberra."

For this proposal two 113,720kVA, 1·0 p.f., 6600V, three-phase, 50 c/s, 3000 r.p.m., cross-compound reheat dual-line turbo-alternator sets would be used, with initial steam conditions 1500 lb per square inch gauge, 1000 deg. Fah., and reheat to 1000 deg. Fah. at 375 lb per square inch absolute.

Two phases (A and B) of each turbo-alternator would be synchronised and then locked together electrically at low speed. The turbine speed would be controlled by one speed lever, and the ship's speed by two, one port and one starboard.

With condenser vacuum 29in and six stages of feedheating, a fuel consumption for propulsion purposes only, excluding auxiliaries, of 0·376 lb/s.h.p. hour was estimated.

Public Works Exhibition

No. II—(*Concluded from page 799, November 11*)

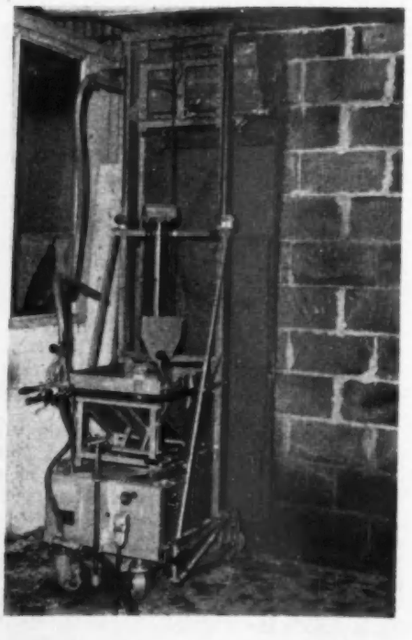
The 1960 Public Works and Municipal Services Congress and Exhibition which opened at Olympia on November 14 closes tomorrow, November 19. We give below some further notes on the comprehensive range of plant and machines being exhibited.

ONE of the new equipments exhibited upon the stand of Millars' Machinery, Ltd., Bishop's Stortford, Herts, is the "Millarmatic" 6/60 asphalt and coated macadam plant which has a rated output of 60 tons per hour with a material having an initial moisture content of 6 per cent. In this machine each size of material is loaded into a separate hopper and under each hopper is a weigh-band feeder. The hoppers straddle a conveyor and the feeders are timed so that a sandwich of material is deposited on the belt immediately the plant starts. The whole plant is operated from a central station, the control for the weigh-band feeders being located in a console on the mixer-platform. When a plant is installed in a quarry or gravel pit the weigh-band feeders can easily be installed to feed material from the existing storage bins. Each size of material is fed through the plant in the right proportion—no screening being necessary and if any of the feed hoppers should run out of material the plant is stopped automatically.

A further conveyor or an elevator takes the blended material up to the dryer having a 5ft 6in diameter by 24ft long drum and heated by a "Stordy Hauck," low-pressure proportioning burner which can burn either gas, oil or, provided a preheater is fitted, medium or heavy fuel oils.

Blended material from the dryer is transported by bucket-elevator to a twin-compartment weigh-hopper which weighs the blended material into batches, and discharges the batches in turn into the mixer. A binder metering and spray-bar system provided includes a binder trough for "epure" mixes. This trough is suspended from a weighing system. The paddle-mixer is of an improved design of 37½ cubic feet capacity.

The filler material, which is handled pneumatically, can be taken in bags, bulk tipper or bulk blown and is taken to a small receiving hopper above the mixer whence it



Wall plastering machine—Millars Machinery

The new Muir-Hill 6 cubic yard dumper—Boydell

is drawn off into a batch hopper fitted with a weigh gear.

The " Richardson " weigh-band feeders of the plant are electrically controlled whilst the remainder of the plant is pneumatically controlled from a console; all doors and chutes are fitted with Maxam pneumatic rams so mounted that they can be serviced easily if necessary.

Another new piece of equipment shown by Millar's Machinery, Ltd., is the plastering machine illustrated on page 834. This machine is aligned by a rail set against the foot of a wall and its vertical alignment parallel to the wall by adjustment of front and rear castor wheels in the base frame. During plastering its movement, speed and the deposition of plaster is controlled by hand levers, power being provided from a compressed air supply piped to the control panel.

Plaster is thrown on to the wall by compressed air from two superimposed rows of nozzles in a plaster container which moves up and down the vertical frame in front of the wall. A lower row of nozzles in this tank throws plaster out in a horizontal stream on to the wall and an upper row of nozzles throws the plaster upwards to deposit it up to the ceiling junction. The plaster deposited on the wall is levelled by smoothing bars at the top and bottom of the plaster tank. These bars are moved by pneumatic means to simulate the hand operations of applying a screed and float when plastering. Plaster scraped off in these operations falls back into the supply container for re-use.

Our illustration shows one of two new additions to the Muir-Hill range—a 6 cubic yard dumper exhibited by E. Boydell and Co., Ltd., of Old Trafford, Manchester. The other new piece of equipment, the " 2X " hydraulic loader, has interchangeable $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ cubic yard buckets. On this machine a pry out force of 2500 lb is provided by double action rams which operate the tip and reset of the bucket. The pay load for the $\frac{1}{4}$ and $\frac{1}{2}$ cubic yard bucket is 1200 lb, and for the $\frac{3}{4}$ cubic yard, 1000 lb. The loader has a maximum forward reach of 3ft 10in and a minimum turning circle of 20ft 9in.

Power is provided by a Petter air-cooled diesel engine developing 17 b.h.p. at 1800 r.p.m. and a maximum torque of 48 lb feet at 1650 r.p.m. A 9in diameter Borg and Beck single plate clutch transmits power through a constant mesh gearbox providing three forward speeds of 5, 9 and 13 m.p.h. and one reverse speed of 5 m.p.h. Power is transmitted to the driving axle by a Hardy Spicer propeller shaft and bevel differential gear. Single acting hydraulic rams lift the main beams and bucket, fluid power for the rams being supplied by a heavy duty pump built into the engine and driven direct.

The new 6 cubic yard dumper is available with a range of all steel bodies designed for handling a variety of bulk materials and is equipped for hydraulic or gravity tipping. It is powered by a six-cylinder Fordson diesel engine developing 96 b.h.p. at 2250 r.p.m. and a maximum torque of 242 lb feet at 1500 r.p.m. Power is transmitted through a hydraulically-operated Borg and Beck 13in double plate clutch to a constant mesh gearbox giving five forward speeds of 2·6, 4·7, 9·0, 16·0 and 20·5 m.p.h. and five reverse speeds, and an auxiliary gearbox giving directional change. Final drive is through a double reduction driving axle incorporating worm and epicyclic gears. A lower ratio driving axle, which is available for operation on hard surfaces, will provide a 50 per cent increase in all speeds and an increased payload of 20,160 lb. The dumper has hydraulic power-assisted steering, two-way driver control and internal expanding air-operated brakes on all wheels.

An automatic concrete batching and mixing plant shown by Winget, Ltd., Rochester, is designed for control by a single operator from a central desk and is transportable in four sections. The four sections, which can be bolted together on site, comprise the mixer, the batchers, and the storage bin, which breaks down into two parts to assist speedy erection. All electric circuits and service connections are fitted with quick action couplings.

The four-section materials storage bin, fed by a conveyor, elevator or grab, has a total capacity of 100 cubic yards, whilst cement is accommodated in a separate bin of a capacity to suit requirements. The materials stored individually within the main bin, together with cement, are fed independently into individual batch weighers. In operation, all materials are not only individually but also simultaneously batch weighed. This avoids the time lag of cumulative weighing and uses fully the capabilities of the high-speed pan " Turbomixer."

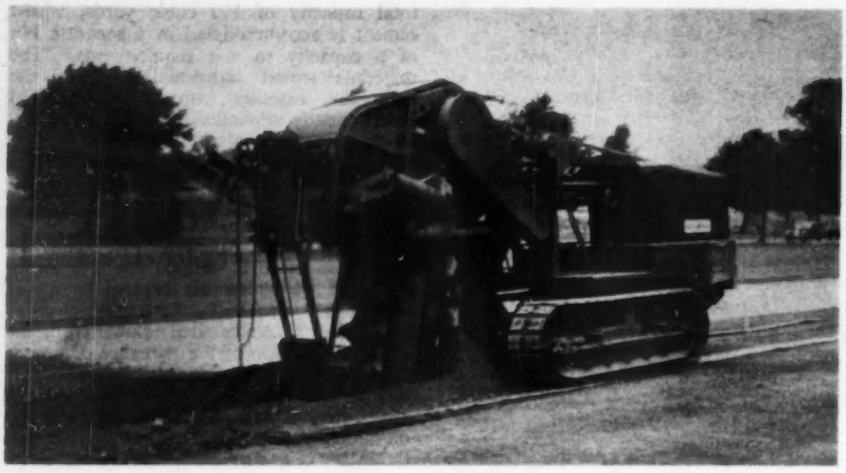
Batch weighing is effected by beams on which the required weights are automatically adjusted by remote control from the operator's control desk, which being electrically-operated, can be sited remote from the plant. Indication of the sequence of operations is given to the operator by signal lights on the panel, for example, gates open, under weight, over weight, batchers zeroed on discharge, &c. Discharge of batches into the mixer is controlled by a sequence timer and the length of time the mix stays in the pan is controlled by a further process timer. Zero to 10 per cent moisture compensation is automatically controlled between the sand and water batches. Automatic setting of the beam scales is effected by the Winget " Autobeam " weighing system which eliminates the need for manual adjustment of the weigh beams.

The materials are mixed in a high-speed " Turbomixer " of 1 cubic yard output capacity having a normal mixing cycle within forty-five seconds to sixty seconds, dependent upon the type of mix. In this external drive machine the power unit is adjacent to the mixing pan and power is transmitted through the gearbox to the mixing rotor through worm and spur reduction gears. The mix is discharged on to an inclined belt conveyor which in turn feeds either directly into a truck mixer or a storage hopper.

Euclid twin-powered scraper in operation—Blackwood Hodge

The " TS-14 " twin-powered scraper illustrated on this page is one of the two main pieces of equipment displayed by Blackwood Hodge/Euclid. This British-built 280 h.p. scraper of 14–20 cubic yard capacity has one engine mounted at the front and the other at the rear, each engine driving its respective axle through a separate " Torqmatic " drive and power train. Power-operated remote controls and full power shift enables the driver of the machine to change from one power range to another without effort.

The machine is fitted with a wide, low bowl for easy loading which, combined with

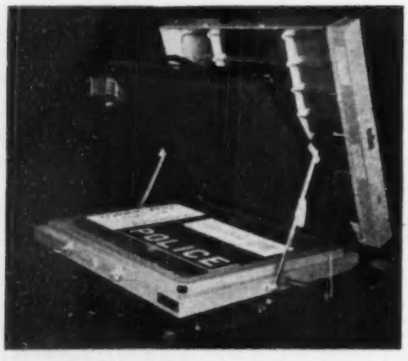


Ditching machine for trenches from 18in to 30in wide and 5ft 6in deep—Barber-Greene Olding

the four-wheel drive, enables loading to be effected under adverse conditions. Each of the four sections of the cutting edge is independently adjustable and reversible. All scraper operations for the bowl, apron and ejector are hydraulically controlled.

Ruston-Bucyrus, Ltd., Lincoln, exhibit the new "11-RB" transit crane of 9 tons capacity mounted on a special chassis constructed jointly by Atkinsons, Ltd., and Ruston-Bucyrus, Ltd. It is powered by a Perkins diesel engine of 98 h.p. and has road speeds up to 32·8 m.p.h.

The superstructure is powered by an air-cooled Ruston diesel engine of 40 h.p. The four main operating clutches are alike in



A small plant for the rapid manufacture of permanent, day-and-night signs

size and type and have single-point adjustment. At present this machine is only available as a lifting crane ; the range of boom lengths is from 25ft to 70ft, whilst offset jibs of 10ft and 20ft are also available.

Transport Equipment (Thornycroft), Ltd., of Basingstoke, Hants, is showing a new medium load 4 by 4 (alternatively 4 by 2) dumper chassis fitted with an Edbro—B. & E. tipping gear and all steel body with scowgate rear end. The chassis, of compact design with a 10ft wheelbase and a turning circle of 49ft, is powered by a Thornycroft six-cylinder oil engine with a maximum output rating of 170 b.h.p. at 2200 r.p.m. and maximum torque (net) of 450 lb feet at 1200 r.p.m.

The drive is transmitted through a 16in single dry plate clutch and a separately mounted combined main and distribution gearbox, with five forward speeds. Independent engagement of front wheel drive is provided, and there is a take-off for full engine power.

The dumper hoist, of the twin underbody slant ram design with 12 tons to 14 tons capacity, is for use with dump bodies up to 11ft mean lengths approximately with scowgate angles up to 30 deg. Triple extension double acting rams give a 70 deg. tip angle and power lowering in the last two ram stages ensures rapid return of body under all conditions. Tipping is effected in eight seconds to nine seconds and the complete tipping cycle in sixteen seconds to eighteen seconds approximately.

An industrial version of the new "Six 354" direct injection diesel engine is shown for the first time at the Public Works Exhibition by Perkins Engines, Ltd., Peterborough. This engine has been developed for use on stationary and mobile plants, including earth-moving equipment, cranes, forklift trucks, generators and welding sets. Its combustion chambers are toroidal-shaped bowls formed in the top of the pistons and slightly offset from centre, fuel being injected directly into the cylinders through multi-hole atomisers.

This 354 cubic inch engine is rated up to 112 b.h.p. at 2800 r.p.m. for industrial use when fitted with an hydraulic governor and used for suitable intermittently-rated applications. At this rating the engine develops a maximum torque of 260 lb/ft at 1450 r.p.m., whilst it develops a maximum torque of 234 lb/ft at 1300 r.p.m. for continuous operation. It is rated up to 85 b.h.p. at 2000 r.p.m. for continuous operation to conditions of B.S. 649 : 1958 when a mechanical governor is used.

Use is made of an extension from the rear of the fuel pump drive horizontal layshaft to provide a light power take-off point for driving such accessories as an exhauster and power steering pump at engine speed.

A heavy-duty drive is available as an alternative to operate larger hydraulic pumps and other equipment from this position, and provision can also be made for power to be taken off the front end of the crankshaft when required.

The new model "774" ditcher of Barber-Greene Olding and Co., Ltd., Hatfield, Herts, we illustrate is particularly intended for cross country ditching for pipeline, irrigation drainage or excavating. It digs trenches from 18in to 30in wide and to 5ft 6in deep. A dual range crowd device gives steplessly variable digging speeds up to 31ft per minute and instantaneous reversing from any digging speed, all digging speeds being selected without stopping the machine or changing gears. A flexible drawbar now fitted reduces the transfer of twist and tilt from wheel to chassis when digging around curves or over uneven ground and a floating differential drive to the digging wheel eliminates long chains and assures equal contact to each side of the digging wheel. A hydraulically-driven spoil conveyor gives variable speeds up to 630ft per minute independent of wheel speed. An automatic electric clutch providing overload protection is controlled by a simple rheostat and may be set for any digging condition. When the machine meets an obstruction this clutch automatically slips until the machine is backed away or the obstruction cleared.

Two new products have been introduced by the Reflective Products division of Minnesota Mining and Manufacturing Company, Ltd., 3M House, Wigmore Street, London, W.1. Road users, at least, in this country will be familiar with the company's "Scotchlite" reflective sheeting for which the angle of reflection is equal but opposite to the angle of incidence, so that it reflects light back towards its origin. This material is already widely available in the form of tape with a backing of pressure-sensitive

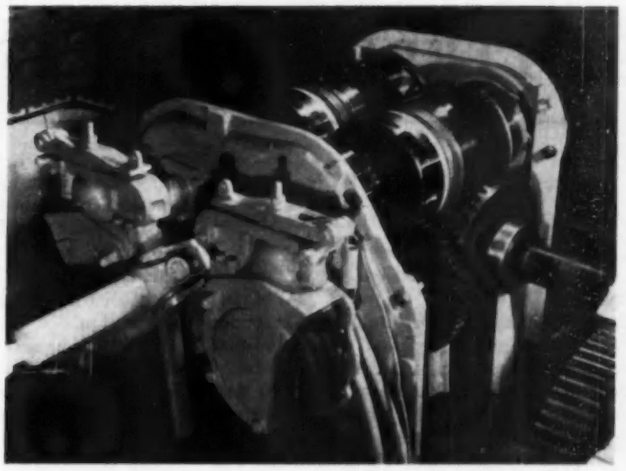
A garment of "Scotch-shield" has a gleaming metallic appearance

adhesive, but since the tape can be stuck once only the scrap rate and time consumed in the manufacture of a reflecting sign can be excessive. Large signs are made from sheets of "Scotchlite" with a backing of heat-sensitive adhesive, and to allow this material to be used by workshops with only a small or occasional demand for signs, the company is now offering a low-cost applicator called the "Economist." The new equipment has a platen 26in by 30in ; pressure is applied to the sign and sheeting by a Neoprene rubber diaphragm loaded by evacuating the air beneath it (the rubber is flexible enough for it to be possible for the operator to see if the sheeting has moved from its correct position on the sign) and the heat source is a pair of 2250W, 230V infra-red elements under an aluminium reflector. The heater is thermostatically regulated to keep the adhesive at just above 178 deg. Fah., and a timer switches it off after a preselected interval. The curing time needed varies according to whether the plant is initially cold or hot, but once it is running the cycle time is about seven minutes.

The sheeting can be applied with this

equipment to virtually any non-porous surface, including an unwanted reflective sign. The available colours of sheeting are red, for danger signs, various other colours, or white, and black or coloured legends can be applied with opaque or transparent inks respectively by silk screen printing. The applicator also handles " Scotchcal " non-reflective coloured film.

Also new is " Scotch-Shield," an aluminised asbestos fabric. This material contrasts with existing reflective fabrics in that the aluminium, deposited *in vacuo*, does not suppress the permeability of the cloth. Consequently, garments made of this material can be worn for long periods without discomfort, a major advantage for, for instance, aircraft crash rescue crews. The reflectivity



Display rig of " Terramatic " transmission. The four gears and four clutches on each mainshaft give two speeds in each direction for each track independently

Four-valve cylinder head ; notice the two points for clearance adjustment. In the extreme foreground is the seal round the injector head which allows all fuel unions to be outside the lubricating oil space

is about 90 per cent and it is claimed that for a given level of protection a garment of " Scotch-Shield " is much lighter and less restrictive than one of the established construction ; because the material can be worn like an ordinary fabric, it has particular application for the protection of, say, foundry workers who may at any moment be exposed to hazard from molten metal or other heat sources. An unconventional application is to use it as a blanket for smothering a fire, a large and tough blanket folding small enough to be carried in a car. To facilitate the construction of complete protective suits for working in ovens, furnaces, or conflagrations, Minnesota Mining and Manufacturing can also supply a transparent plastic with a film of gold on the outside from which visors can be made. It should be emphasised that, since these suits are permeable, it is vital that no attempt be made to cool the wearer by wetting down the outside of the suit.

The 5½in by 6in diesel engines of Cummins and Rolls-Royce have both been revised in the quest for higher powers, and the new models were on show. In the case of the Cummins the bore has been increased to 5½in, but without either reducing the liner thickness—on several of the different variants ratings are limited by the onset of liner vibration and the resultant corrosion—or increasing the cylinder centres. The overall dimensions of the engine are in fact virtually unaltered, but the crankcase casting has been modified to make provision for oil jets to cool the pistons in the more highly rated variants. The crankshaft also has been redesigned to match the higher torques involved. One interesting modification affects the PT fuel system, which gives any Cummins engine an appearance of simplicity ; the fuel system has now virtually disappeared from view. It will be recalled that since the P(ressure) T(ime) system works by controlling the pressure at the metering orifice of each injector, any damage to a fuel manifold was irreparable. The vulnerable manifold has now been rendered inviolable by substituting a fuel gallery running along inside the cylinder head, the inlet to the injector now taking the form not of a union but of a hole in the side of the injector with O-ring seals above and below it. The automotive ratings of the enlarged six-cylinder engine are (naturally aspirated) 240 h.p. at 2100 r.p.m. (maximum brake mean effective pressure, 116 lb per square inch) and (Turbo-diesel) 355 h.p. at 2100 r.p.m. and 380 h.p. at 2300 r.p.m. (maximum brake mean effective pressure, 176 lb per square inch.).

The Rolls-Royce Mark IV engines, in contrast, have been developed to give an enhanced performance at the higher speeds from the original swept volume. This has been done by changing to a four-valve cylinder head to improve the breathing. Whereas all previous four-valve Rolls-Royce engines have had overhead camshafts, the " C " series are pushrod engines, and to avoid severe mechanical complication it was necessary to maintain the plane of symmetry of the cylinder parallel with the crankshaft. This meant that the exhaust port would run right across the front of the head of each cylinder and the inlet port right across the back, and hence it became impossible to maintain the monobloc head castings that have for so long been an important feature of the Rolls-Royce engine. The Mark IV engines have separate heads for each cylinder, retained by clamps on pairs of screws passing between the heads. The balance beam connecting each rocker to two valves is supported on a slider, thus relieving the valves of the side thrust generated by the rocker gear, and it is claimed that this results in increased reliability. These engines also are limited by liner erosion—it will be recalled that the liners are chrome plated—and a new design of piston has been fitted to reduce this form of deterioration. The 743 cubic inch version, with Holset turbo-charger, has an automotive rating of 335 h.p. at 2100 r.p.m. and a maximum brake mean effective pressure of nearly 180 lb per square inch at 1550 r.p.m. As mentioned earlier, it is at the higher speeds of 1400 r.p.m. and above that these engines show an improvement in performance.

On the stand of J. I. Case Company, Ltd., is a full size demonstration rig of the " Terramatic " transmission for crawler tractors. The rig is complete with sectioned engine and torque converter, and an interesting detail is that the engine is fitted with an example of the Roosa Master distributor pump that has influenced so extensively fuel injection equipment in this country. The transmission consists of two forward/reverse high/low gearboxes, one for each track, so that by engaging a different gear on each side the vehicle can be turned with power recirculation between the tracks, thus saving greatly in power. In addition, there are individual brakes for each track, and while the gearbox clutches are all power-operated the disc brakes are energised by the driver. The construction can be perceived in our photograph : at the back of the box are the reversing trains. These comprise four gears of the same diameter in meshing pairs, with a clutch to couple each to its shaft. A countershaft coupled by reduction gearing to the torque converter output drives the left-hand gear of the front pair (the countershaft is to the left of the centre of the box) and the right-hand gear of the rear pair (since the countershaft gear must obviously overlap the left-hand gear of the rear pair, the right-hand one has to have a width twice that of the other gears); thus the two gears on each shaft are running in opposite directions, and closing one or other clutch gives forward or reverse. Because of the slight difference in the size of the countershaft gears, forward and reverse are not numerically identical ratios. The two-speed trains are of great simplicity and are again selected by clutches on the main shafts. All the clutches are energised by oil under pressure, two being supplied from each end of the main shaft. As mentioned above, a disc brake is fitted on the front of each output shaft, and the initial movement of each brake pedal serves to cut off the oil pressure from the clutches on the corresponding main shaft. As can be seen, all the gears are straight cut, and the transmission gives an impression of severe simplicity. On the demonstration rig, the transmission momentarily comes to rest during changes because one clutch is engaging before the other is free, but when the tracks are on the ground this effect will naturally be suppressed. The makers offer a twelve-month guarantee on this transmission.

LETTERS AND LITERATURE

Letters to the Editor

THOUSANDS OF MILLIONS OF POUNDS TO BE SAVED ?

SIR,—Your editorial on conversion of railways into roads, on page 744 of the current issue, seems to omit all mention of one of the most important questions—that of staff. One train, manned by a crew of two or three, can handle at least 400 passengers or 400 tons of goods, which would require (in broad figures) ten road coaches or forty 10-ton lorries (if such exist) and therefore ten men or forty men in the respective cases. No doubt there can be savings on other staff, but I doubt very much whether there would be anything approaching compensation.

There are other very big questions too. The great majority of railway mileage is not capable of conversion to first-class road, let alone motorway, standards without huge expenditure of capital—in many cases it is simply not practical at all from dimensional considerations.

Maybe you have in mind the provision of automatic guidance and control to mitigate these problems—you cannot have overlooked them—but I for one would not care to trust such a system to take me safely through a tunnel with clearance measured in inches rather than feet, and this solution would, of course, involve even more expenditure.

Also, it is easy to compare flow problems on open stretches of road and railway, but junction and terminal problems are quite another kettle of fish ; one can't say simply that terminal and station problems will be non-existent for the rail roadways because they will be transferred to the existing roads.

The biggest initial problem may be to agree on what constitutes a properly representative stretch of railway for experiment.

So far as I have seen, there is not yet a convincing case on paper even for experiment—for example, a case worked out on the basis of an actual route—so it seems rather unworthy of a high-class technical journal to stress only one aspect of the matter without hinting at the others.

ROY G. DE BRAY

Twickenham.
November 7, 1960.

PROGRESS OF THE PARK LANE IMPROVEMENT SCHEME

SIR,—Thank you for publishing the interesting and useful article on the progress of the L.C.C.'s Park Lane improvement scheme in your issue of October 28. It does, however, contain one misleading statement.

The prohibition of steel sheet piling in the construction of the Knightsbridge-Piccadilly underpass was decided on in the interests of the patients of St. George's Hospital and because of the possible damage to the Hospital's highly sensitive medical and scientific apparatus and equipment due to ground shock and vibration if steel sheet piling was driven. Electro-cardiographs, for instance, could not operate while piles were being driven. (The hours of night work are also being restricted for the sake of the patients). Another factor was the safety of the escalator tunnel at Hyde Park Corner tube station.

The decision was taken after consultation with the hospital authorities and the London Transport Executive. No other considerations affected the decision not to use steel piling.

The introduction of the I.C.O.S. Veder process, now being used in this country for the first time, makes it possible for the underpass to be constructed very close to existing buildings with the minimum of noise and vibration.

R. EDMONDS
Chairman of the L.C.C.
Town Planning Committee.

County Hall,
London, S.E.1,
November 9, 1960.

TRANSPORT AND THE WEATHER

SIR,—May I suggest that in the matter of wheeled transport versus the elements, raised by Dr. Moore in your issue of November 11, allowance must be made for the fact that when motor vehicles are using the new road network, obtained by paving the former railway system, they will be spared the worst hazards of the highways in bad weather? For instance, hills and corners will be absent, also pedestrians, cyclists, and other obstructive traffic ; installed lighting will be the rule rather than the exception ; snow clearance vehicles will be able to travel at speed, in the traffic stream, and deal with snow as it falls ; emergency speed limits will be imposable, as on American motorways. Altogether conditions will be so very much superior to those normally associated with road transport that it is perhaps unfair, or even irrelevant, to compare the hard-weather performance of road transport (meaning highway transport) with that of rail transport, in the context of railway conversion. Not that railways emerged from the comparison overwhelmingly creditably in Dr. Moore's letter : it is to be noted that he ended by rating their advantage potential, not actual.

One cannot always foresee potentialities. Who was able to forecast the invention of the cats-eye? Something equally revolutionary may materialise at any moment, from out of the blue, as a further aid to motor transport ; and one can always fall back on commonplace electronic guidance, if one must. Since Dr. Moore did not conclude his final sentence without first using the qualifications "appear," "provided," and "from this point of view," it seems that he does not rule out all possibility of the greater share of hard-weather potentialities lying with motor transport after all. That will be a point of encouragement to the 50,000,000 inhabitants of this country who are intent on using motor transport whatever its potentialities.

Finally, in order to maintain perspective, it has to be remembered that on only about fifteen days out of 365 does Britain's weather obtrude at all seriously ; this is but a 4 per cent branch of the subject. However, since it failed to occupy that proportion of the seventy-seven-letter correspondence reproduced in your book "Railways into Roadways?" Dr. Moore will have contributed illustriously to the next volume—one hopes—of your ultimate symposium of correspondence and memorable leading articles on railway conversion.

T. I. LLOYD

Guildford,
Surrey,
November 14, 1960.

GERMANIUM AND SILICON POWER RECTIFIERS

SIR,—The technical aspects discussed by Dr. Read in his article of September 30 have possibly diverted attention from his references to cost.

Dr. Read reasonably asserts that his conclusions refer only to the present day. If we look a little further, we may well conclude that with industrial service generally, first cost of conversion plant will be the prime factor.

Mr. Corbyn in his letter published October 21 has given accurate and powerful reasons for the preference already being shown for silicon power rectifiers in the commonest industrial range of 200V to 450V ; cost saving is readily apparent when using the higher voltage silicon cell. High voltage silicon cells have the additional merit of reducing the measures necessary to control over-voltage phenomena in equipment within this range ; the improved silicon cells now in service have typically a six-times transient over-voltage capability.

Turning to lower voltage applications where germanium rectifiers are stated to be preferred, it must be remembered that higher efficiency is primarily reflected in the operating costs. Where first cost of plant is the criterion, however, efficiency is less important and it can be argued that selenium rectifiers will give a less expensive design for some considerable future period. In fairness to Dr. Read it should be pointed out that opportunities for comparing the best selenium and silicon rectifiers are limited, again because only a few manufacturers are making high quality rectifiers of both types. But the long term reliability of selenium rectifiers is now well proven, since unlike the germanium rectifier whose application dates from 1953, selenium rectifiers have been in service for some twenty-five years with continuous improvement from developments during that period.

We may expect to see in the future an extremely limited field of application for germanium rectifiers, particularly in view of the present concentration of work to improve

manufacturing processes on silicon cells. The resulting cost reductions will inevitably influence the user when considering the relative technical advantages Dr. Read has described.

D. R. COLEMAN
B.Sc.(Eng.), A.M.I.E.E.

Harlow,
Essex,
November 11, 1960.

Book Reviews

Introduction to Laplace Transforms for Radio and Electronic Engineers. By W. D. DAY. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 32s. 6d.

THE mathematical starting standard assumed for this book is elementary differential equations and the properties of complex numbers. Engineering students, particularly those in the field of radio and electronic engineering, should have the necessary knowledge and proficiency.

An original introduction to Laplace transformation has been adopted, and one that is particularly suitable for electrical engineering students. It is first of all pointed out that the familiar method for the steady state solution of circuit problems, which contain resistance, inductance and capacitance with a sinusoidal voltage source, involves a transformation process of the time functions into functions of a new variable, *jw*. This converts the problem to the solution of algebraic equations instead of differential equations. Laplace transformation is then introduced by its application to the solution of simple differential equations, showing that their solution—including obtaining the necessary constants from the initial conditions—is achieved by simple algebraic processes. The Laplace transform is defined, and the transforms are obtained of all the simpler functions that are required in the first part of the book. The notation adopted is to use *p* as the transformed variable, and to denote Laplace transforms by placing a bar over the corresponding time function. Mention is made of some other alternative notations. The differentiation theorem and the " shifting " theorem are proved from their definitions ; the formula is derived for the " expansion " theorem. This, all within the first two chapters of the book, provides sufficient theory to enable Laplace transforms to be applied to the solution of a number of circuit problems.

The third chapter discusses some of the properties of the transforms and shows how information about circuit behaviour can be deduced from them without having to carry out the inverse transformation. One example is the conditions for stability which can be determined by consideration of the roots of the transform denominator. This is illustrated by its application to valve circuits. A number of further theorems are then given, including the finding of the transform of a periodic function. The " unit step " function and the " unit impulse " or " delta " function are introduced. The second " shifting " theorem, translation in the time frame, is derived as a preliminary to finding the effect of applying pulses to circuits, including the response of an N-stage amplifier.

The first five chapters, which occupy about half the book, are self contained. They provide a sufficient number of working rules that will enable the reader to make practical use of Laplace transforms with no knowledge of complex variable theory. The sixth chapter provides a very good introduction to this theory, explaining analytic functions, contour integration, singularities and residues. The fundamental theorems, such as Cauchy's, are stated and demonstrated but not formally proved. This leads on to the inversion theorem and to the method of finding inverse transforms by means of residues. The author makes the point that where an alternative method is available, it will normally be shorter than the use of the inversion theorem. It is doubtful whether many readers of this book will come across practical problems, which lend themselves to solution by Laplace transforms, but which cannot be solved by the use of tables and some of the straight forward theorems. If the problem does require the use of contour integration, it is most unlikely that they would have acquired sufficient facility in its use. However, the inclusion of this theoretical work is justified. It provides the inquiring reader with the answer to the question why as well as to how, and it prepares the ground for more comprehensive treatments.

Two important chapters follow, neither of which demands a knowledge of complex variable theory. The first shows the use of the Laplace transformation in the solution of partial differential equations. This is illustrated by practical application to various transmission line problems. The second covers convolution, the product or Borel's theorem, and the impulsive response and the indicial response of circuits. In the final chapter mention is made of other transformations ; the relation between Fourier and Laplace transforms are explained ; and the use of the Heaviside operator and the Laplace transform are compared.

A small bibliography and a short table of transforms are contained at the end of the book, together with the answers to some exercises which are at the end of most of the chapters. Great care has been taken throughout to give clear explanations and to include practical examples to illustrate the working. They are taken in the main from communication engineering problems. The book is well produced with good diagrams and clearly set out equations. Examples can be cited where a better choice of symbols might avoid possible confusion. In section 3.4 " a " and " b " are used both for the roots of an equation and for the coefficients. In section 5.7 " b " is used for the duration of a pulse, and " a " for the delay. The reader is asked to compare an equation containing these two quantities with a previous equation where the pulse duration is the interval between two times, specified by " a " and " b." When dealing with transient solutions an apparent anomoly is explained, showing how the use of the Laplace transform gives the correct answer which is different from the one that appears at first sight : unfortunately, there is an error in the working in this particular section. These are, however, very minor criticisms. This book is well described by its title. It is an " introduction " and as such it is highly recommended to meet the needs of the engineering student and even for the engineer who is unfamiliar with the subject. It is written for radio and electronic engineers and is particularly suited to their needs.

Fliesspressen von Stahl. By HEINZ D. FELDMANN. Berlin-Göttingen-Heidelberg : Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3. Price DM.31.50.

WHILE extrusion of metals has been practised for some sixty years, the application to steel only dates back to the immediate pre-war period. The use of the process for producing munitions caused it to be shrouded in secrecy, and details have become generally known only during the last fifteen years. The present book sets out the subject comprehensively, concentrating upon the essentials for the student as well as the designer and the production engineer. The history of the process, the various forms which it has taken, material flow, stress distribution and power requirements are discussed and a detailed survey is presented of the metallurgical aspects, and the various applications as affected by the obtainable strength of extruded material, surface quality, and any subsequent treatment necessary. Choice of die steels, design, manufacture, and maintenance of dies, lubrication, furnaces, and presses are dealt with in full detail in the latter chapters.

Basics of Induction Heating. By CHESTER A. TUDBURY. John F. Rider Publisher, Inc., New York. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 63s.

THIS book on the fundamental principles of induction heating is printed in the U.S.A. and is intended by the author " to be readily understood and enjoyed by any reader familiar with the simple rules of electricity." It contains a great profusion of carefully simplified self-explanatory diagrams, many of which are strongly reminiscent of strip cartoons. This method of obtrusive visual presentation can be an excellent educational aid. Used in moderation it is an admirable means of presenting ideas in a readily assimilable form but an excess of it can be extremely wasteful of space and irritating to the reader. More than half of the book under review is devoted to these cartoon-like diagrams. Many of them are useful, no doubt as *aides-mémoire*. Many others are trivial and superfluous—the more so because the text, throughout, is a model of lucidity and covers the subject very thoroughly.

The book is divided into two parts. The first deals with the characteristics of the induction heating coil and the relationships between the coil and the workpiece. The second is concerned with the relationships between the coil and the electrical equipment that produces the power for induction heating. Each chapter includes a number of worked examples and is followed by a series of questions and quantitative problems but as the answers, are not given, the reader has no means of checking his work.

Books Received

Atomic Theory for Students of Metallurgy. By William Hume-Rothery. The Institute of Metals, 17, Belgrave Square, London, S.W.1. Price 50s.

Nuclear Engineering Monographs. No. XI. *Nuclear Reactor Stability*. By A. Hitchcock. Temple Press, Ltd., Bowling Green Lane, London, E.C.1. Price 12s. 6d.

Proceedings of the Engineering Materials and Design Conference 1960. Heywood and Co., Ltd., Drury House, Russell Street, London, W.C.2. Price 42s.

Guide to the Coalfields, 1960. Edited by R. H. Walkerdine and E. G. Corbin. The Colliery Guardian Company, Ltd., 30 and 31, Furnival Street, London, E.C.4. Price 20s.

Direct Conversion of Heat to Electricity. Edited by Joseph Kaye and John A. Welsh. John Wiley and Son, Inc., New York. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 70s.

Polythene. The Technology and Uses of Ethylene Polymers. Second edition. Edited by A. Renfrew and Phillip Morgan. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 165s.

Mechanics of Materials. By Archie Higdon, Edward H. Ohlsen and William B. Stiles. John Wiley and Sons Inc., Publishers, New York. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 62s.

State of the Machine Tool Industry

TWO documents were issued last week relating to the machine tool industry of this country. One was a report by a sub-committee of the Machine Tool Advisory Council appointed by the President of the Board of Trade to consider Professor Melman's Report to the European Productivity Agency ; the other a Statement by the Machine Tool Trade Association and the Department of Scientific and Industrial Research summarising the main conclusions and recommendations of a D.S.I.R. confidential report on the research and development requirements of the British machine tool industry and the measures agreed upon between the Government and the industry to implement the recommendations. Below we print abstracts from both these documents. Editorial comment appears on page 823.

Conclusions of the Sub-Committee

We reject Professor Melman's main recommendation that mass production of machine tools must be introduced rapidly into the machine tool industry of Western Europe. We recognise, however, that important advantages are obtained when manufacture is carried out in large production units and consider that there remains scope for further rationalisation in some sectors of the United Kingdom industry.

We appreciate the sincerity with which Professor Melman has stressed the likelihood of an early threat in third markets from Soviet machine tools. We point out that the economic system of the Communist bloc in any case enables them to sell overseas at prices which do not reflect costs of production and that they may also be ready to offer loans and favourable credit terms to particular countries. We consider that so far as manufacturers are concerned, the best counter to this threat is technical superiority of their product which cannot be affected by politico-economic factors. In this connection we stress the importance which Western observers should attach to the intense effort applied in the Communist bloc to research and development.

The inquiries proposed by Professor Melman were related to the main concept which we have rejected. They have, however, formed a useful basis for a wide-ranging discussion with manufacturers and users as a result of which we make the following recommendations :

(i) The scope for further standardisation of components is limited except as a sequel to any reduction in the number of designs of machine tools that may arise from rationalisation between firms making similar products, but there is both scope and need for further standardisation of those parts of machine tools of primary importance to users, particularly features which are associated with the attachment and location of tooling and ancillary equipment. The machine tool industry should set up an effective organisation to establish greater standardisation in those areas.

(ii) Leading manufacturers of unit head and multi-station machines should collaborate to achieve greater standardisation of assembly and location details and as an immediate step the machine tool industry should adopt the standards for modular units recently adopted by the American automobile industry.

(iii) The Machine Tool Trades Association, British Standards Institution and the Federation of British Industries should be invited to consider the desirability of recruiting technical staff in order to speed up the process of formulating new standards.

(iv) We are impressed by the achievements of electronic firms concerned with machine tool control. We note that using industries seem to be slow in recognising the advantages of the more complex forms of electronic control of machine tools, suggest that this is probably because of the lack of unchallengeable factual cost information on these new techniques and note that a report on a useful series of trials carried out in Royal Ordnance Factories is shortly to be published. We believe that further trials, of wider scope and under the direction of an independent authority, should be carried out and we recommend that the Government should consider whether their resources could usefully be made available to assist these experiments.

(v) We hold that machine tool firms should not enter the field of electronic manufacture, but should maintain close links with electronic firms and to this end recruit suitably qualified engineers.

(vi) We draw attention to the need for a more basic approach to the problem of applying electronic techniques to machine tools. We mention problems on which research and development work is required by joint teams of machine tool and electronic control system engineers. We recommend that this work should be carried out in industry partly through development contracts placed by the appropriate Government Department.

(vii) A market survey of the likely demand for machine tools for five to ten years ahead would be of great value to the industry. We appreciate the difficulties in such a survey, but suggest that the Machine Tool Trades Association should discuss its feasibility with a suitable Agency.

(viii) The Machine Tool Trades Association should be invited to organise a survey, if no more than a sample check, of the age of machine tools currently operated in the United Kingdom.

We are particularly concerned that our rejection of Professor Melman's main recommendation and of most of his specific suggestions should not be taken to mean that we believe there is no room for improvement in the United Kingdom industry. With this in mind we offer our views on various aspects of the industry not specifically mentioned by Professor Melman (Part IV).

We have examined the criticism that the British machine tool industry does not respond quickly to rises in demand. We consider that comparisons with the industry in the United States, which is more successful in this respect, are unhelpful as conditions differ so radically. The main obstacle to rapid increase in United Kingdom machine tool output is the difficulty of recruiting additional skilled labour. We suggest that there may be occasions when the machine tool industry should attract more skilled labour by better conditions and recommend that at present managements should consider further how they might overcome the difficulties involved in moving part of their production to Development Districts.

We are struck by the fact that there is little complaint about the quality of manufacture of United Kingdom machine tools. The United Kingdom industry is recognised throughout the world as an excellent producer of standard machine tools of all categories ; it supplies almost the whole home demand for such machine tools and exports approximately 30 per cent of its production. But the demand for such machines, though it will continue to be heavy, has not recently increased as rapidly as the demand for more complex types, and this tendency, particularly as under-developed countries start manufacturing the simpler types of standard machines, is likely to continue.

We consider that as a generalisation it is safe to say that the performance of the United Kingdom industry in comparison with its Western competitors suffers from over-concentration on the production of standard machine tools and that this accounts for its shrinking share of the increased world trade and for the high proportion of machines imported into this country—(which reduce the industry's performance as a net exporter to 6 per cent).

Basically this over-concentration on standard types springs, in our view, from the lack of a sufficiently intensive development effort. This same factor accounts for much of the criticism that our country is over-dependent on licensing agreements to manufacture machine tools of foreign design and that it is reluctant to meet the special needs of particular customers. Behind this weakness lies a shortage in the industry of qualified technical staff. (This shortage must also imply in some sectors a weakness in production techniques though we do not believe this weakness to be widespread.)

The basic shortage of specialised staff for research and development is being actively tackled. Meanwhile we stress that well qualified engineers can usually be found by any firm that shows these men a company structure big enough to offer a good career and a development effort big enough to ensure a dynamic future.

We note that the intention of the Department of Scientific and Industrial Research to place development contracts will require strong development teams and will thus encourage co-operative arrangements between machine tool firms. We recommend that in placing some of these contracts the Department should include specialist firms outside the machine tool field.

As the whole tenor of our Report is to the effect that the key to the industry's future lies in technical excellence :

(i) We welcome the efforts being made by the industry to establish a co-operative Research Association and we recommend that the possibilities of linking this with a teaching centre on the lines of the Technische Hochschule in Aachen, should be investigated.

(ii) We consider that the present rate of research and development by the industry (estimated at £3,000,000 per annum) is much too small and that the figure should be increased to 10 per cent of the industry's turnover, say, to £8,000,000 a year by the end of 1964. Some 20 per cent of this proposed increase should relate to work of a more fundamental character of at best only long-term commercial value to the machine tool industry. We regard this as properly qualifying for assistance from public funds.

(iii) To handle these increases in research and development we consider that some 250 to 300 additional qualified engineers and scientists must be attracted to the machine tool industry by 1964. We think this can be achieved.

(iv) We recommend that the development programmes at (ii) above should be based on an analysis jointly by the Department of Scientific and Industrial Research, the machine tool industry, and the user industries, of the long-term future trends of both manufactures and of manufacturing techniques in

order that the most profitable lines of development can be established. We stress the continuing importance in this development planning of close consultation with the user industries and with neighbouring technologies such as electronics, control engineering, data processing, &c.

(v) It is our considered view that the greatest single need to-day of the British machine tool industry is for a major increase in development effort by qualified engineers.

Though we have been unable to endorse Professor Melman's principal recommendation that Western Europe should mass produce machine tools or the majority of his specific recommendations, we have welcomed the opportunity which the detailed examination has afforded for considering the problems and the prospects of the United Kingdom machine tool industry. The more deeply we have probed into the problems the more we have felt how difficult it is to make useful generalisations about an industry necessarily so diverse. We feel that this may in part, but only in part, explain why the industry has so frequently in the past failed to explain itself to the public.

Our own report must in part be critical as we aim at showing how the industry can better its performance. We hope that energy will not be wasted either in unfairly exploiting these criticisms or in unnecessary defence against them. Men working in this industry can rightly be proud of its past and present achievements. What matters, however, is the future and we are confident that our main recommendations point the way. This is an industry of such importance and promise that it offers an exciting challenge not only to the able men already working in it, but to many others who may not yet have thought of it as a likely field for their skill and enterprise.

Joint Statement by M.T.T.A. and D.S.I.R.

The Machine Tool Trades Association and the Department of Scientific and Industrial Research announce that the following steps have been taken to implement the recommendations of the D.S.I.R. Report on the "Research and Development Requirements of the British Machine Tool Industry." The Report was written following a survey carried out by the D.S.I.R. with the full co-operation of the Machine Tool Trades Association whose members afforded facilities for the study of the production, design, development and research activities of over forty of the leading machine tool manufacturers. The recommendations were :

(1) That these conclusions should be brought to the attention of the authorities responsible for education and technical training, namely, the Ministry of Education and the University Grants Committee.

(2) That because of the shortage of teachers in the appropriate subjects, the industry itself should help in all possible ways.

(3) That schools of research in machine tool technology should be encouraged in appropriate centres and that the industry and Government should co-operate in providing resources for this development.

(4) That the machine tool industry should consider how it could make greater use of the research facilities provided by Government Research Stations and grant-aided Research Associations and whether it should establish a research or design organisation of its own.

(5) That D.S.I.R. should consider what measures could be taken to make its existing resources of more effective use to engineers and designers in the industry.

(6) That as an immediate stimulus to development special consideration be given by D.S.I.R. to proposals for civil development contracts for promising new machine tool designs or major improvements to old designs.

Up to the present time the following action has been taken :

On Recommendation 1.—The conclusions of the survey were brought to the attention of all parties concerned, including the Ministry of Education, the Board of Trade, and the University Grants Committee. In addition, the Minister for Science (Lord Hailsham) personally called a special meeting last March, to which representatives of the following bodies were invited : the Machine Tool Trades Association, the Ministry of Education, the Board of Trade and the Department of Scientific and Industrial Research.

On Recommendation 2.—Three colleges of advanced technology (Birmingham, Loughborough and Salford), with the support of the Ministry of Education, have for several years provided courses with a special bias towards the needs of the industries. Facilities for tuition and research will be developed further and the Ministry of Education has invited the industry to assist in reviewing the curricula of existing courses at technical colleges and colleges of advanced technology and in devising any necessary new courses. The industry is providing a number of specialist lecturers in connection with a Design Scholarship course sponsored by the Machine Tool Trades Association at Manchester College of Science and Technology. The Machine Tool Trades Association is also appointing to its staff an appropriately qualified person to look after its education and training interests.

On Recommendation 3.—Schools of research and higher training in machine tool technology are being developed in the Manchester College of Science and Technology, the University of Birmingham, the Royal Technical College, Salford and the College of Aeronautics, Cranfield. The growth of three of these schools is illustrated in the accompanying Table I. Research grants amounting to more than £100,000 over the next two to three years have been made to the four institutions* by D.S.I.R. who are organising regular meetings under the chairmanship of a member of the Research Council, at which those engaged in these researches can report and discuss progress made. The industry has already provided for ten scholarships at the Manchester College of Science and Technology to be taken up each year by engineers from the industry for a two-year advanced course in machine tool design. The research effort at one or two of these centres is being augmented by private contracts placed by machine tool manufacturers. The first Machine Tool Design and Research Conference in the United Kingdom was held at the University of Birmingham in September. The Conference, organised by Professor S. A. Tobias, was attended by nearly 200 delegates drawn in equal proportions from research centres and from engineering industry, including nearly seventy engineers from machine tool firms. Twenty-three original papers were presented, including six from overseas, and will be published in a new journal to be issued next January—*The International Journal for Machine Tool Design and Research*. The Conference is to be an annual event and will be held next year at Manchester. It will help to give to this field of engineering science the prestige which it has hitherto lacked in this country.

On Recommendation 4.—The Machine Tool Trades Association has already announced the industry's decision to establish a Machine Tool Industry Research Association and its intention to apply to the D.S.I.R. for a grant. The appointment of a Director is now under consideration. The D.S.I.R. is discussing with the M.T.T.A. a scheme for the publication of a series of "Notes for Machine Tool Designers." They will comprise a digest of research data from many sources presented in a readily usable form.

On Recommendation 5.—The National Engineering Laboratory of the D.S.I.R. at East Kilbride, near Glasgow, is in close touch with the machine tool industry and has, with the National Physical laboratory, pioneered the use of moiré fringes for machine tool control and has developed new hydrostatic power transmissions for machine tools. It has already started a series of exchanges of personnel with industry at research level and, in addition, the laboratory is considering the introduction of short courses for machine tool designers, aimed particularly at assisting them to interpret more beneficially the published results of research. The work on machine tool research at N.E.L. is being increased.

On Recommendation 6.—The D.S.I.R. is considering several proposals for the development of advanced machine tool designs. Their technical and economic aspects are being examined.

In the industry itself, there are welcome signs of renewed and vigorous interest in research. Several firms, in addition to giving support to the new Research Association, are embarking on ambitious research and development programmes of their own.

Table I—*Growth of Schools of Research and Higher Training in Machine Tool Technology*

	University of Birmingham, Department of Mechanical Engineering		Manchester College of Science and Technology, Department of Mechanical Engineering		Royal Technical College, Salford, Department of Mechanical Engineering	
	1958	1960	1958	1960	1958	1960
Undergraduate students	111	117	190	164	84†	189†
Research students—total	6	18	21*	26*	—	2
of which on machine tools	0	10	5	6	—	2
Teaching staff—total	16	19	19	19	31	40
of which on machine tools	0	4	3	3	1	7
Research staff—total	0	3	6	6	1	3
of which on machine tools	0	2	6	6	0	2

* Post-graduate students. † Students working for Dip.Tech.(Eng.) in Mechanical Engineering.

* Professor S. A. Tobins, University of Birmingham : Three grants totalling £36,985 (£3985 for one year from October 1, 1959, £1800 for one year from October 1, 1960, and £31,200 over three years from March 1, 1960). Dr. F. Koenigsberger, Manchester College of Science and Technology : £33,100 over two years from August 1, 1959. Mr. A. W. J. Chisholm, Royal Technical College, Salford: £13,185 over two years from October 1, 1960. Professor J. Loxham, College of Aeronautics, Cranfield : £18,000 over two years from February 1, 1960.

Old Steam Roller Preserved.—After eighty-two years of continuous service, an Aveling steam roller has been presented to the Norwegian Technical Museum, on the outskirts of Oslo, for preservation. The roller (works number 1457) was built for the Oslo Municipality by Thomas Aveling in Rochester, Kent, in 1878, only thirteen years after the practicability of steam road rolling had been proved, and has worked at Oslo ever since. The last journey, which took the roller to the Museum under its own steam, brought to an end travels estimated to equal twelve circuits of the world.

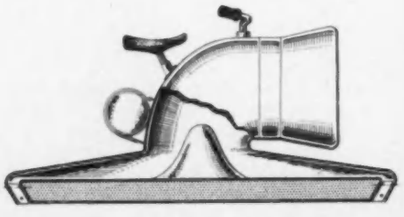
Cycle and Motor Cycle Show

The 1960 Cycle and Motor Cycle Show at Earls Court celebrates the Golden Jubilee of the promoters, the British Cycle and Motor Cycle Industries Association, Ltd. It was opened last Saturday by the Minister of Transport and continues until tomorrow.

THE exhibits include few innovations among cycles and motor cycles in the strictest senses of the terms. There was on show, however, a small ground effect machine designated a " Hover Scooter " and built in the United States by Rhoades Incorporated ; its relationship to a cycle is that it is steered in the corresponding way by developing bank, although the rider's movement is exactly the opposite, i.e. to tighten a turn he leans out on a cycle and in on a " Hover Scooter." Having no wheels, the cushion-rider has no stability in yaw at other than high speeds, when the tail fins become effective, and so a yaw control is provided. This is achieved by fitting 116 small vanes in the annular jet and connecting the vanes, which are joined by a cable running right round the jet, to a pair of handlebars. Movement of the bars deflects the blades and gives the jet sheet a helical motion ; no change in the magnitude of the lift developed can be detected. The machine has a 250 c.c., twin-cylinder, two stroke Yamaha engine driving the forward-facing fan ; the weight of the engine is naturally proportionately high in such a small ground effect machine, and so particular attention has been given to the efficiency of the air ducts. Our diagram shows that the internal passages have been shaped to avoid losses due to severe expansions, and in addition a flexible fabric curtain has been fitted which gives some economy in power by reducing the minimum height necessary for moving over an irregular surface. In view of the conspicuous resemblance in principle of this machine to the Cockerell " Hovercraft " in which patent rights are claimed by the National Research Development Corporation, it may be recorded that the principles on which it is based were demonstrated in the United States in 1953 by N.A.C.A. (now N.A.S.A.) and at the U.S. Navy Taylor Basin. The Rhoades vehicle will be marketed in this country by Autohall (Car Hire), Ltd.

A more conventional but yet distinctive scooter making its first public appearance is the Velocette " Viceroy." It may be recalled that Veloce, Ltd., produced with their shaft-drive " LE " one of the first of the modern unit-construction machines built in this country. For an open-frame design, however, the firm once again adopted an unconventional solution and on the " Viceroy " the engine and transmission are separated by a propeller shaft running under the footboard. The advantages of this configuration are a more nearly optimum weight distribution, the ability to get at the engine without removing any cowlings—the sparking plugs are beneath plastic covers just in front of the footboards—and the fact that no cooling fan is needed. The engine itself is also unconventional ; like all the other small Velocette engines, it is a horizontally opposed twin, but, on the presumption that the scooter is accorded less utilisation than a conventional motor-cycle and therefore initial costs compare more heavily with running costs, it is a two-stroke. Clearly, a two-stroke twin of this configuration has the same firing frequency as a single, and the substitution of an unbalanced couple for an unbalanced force is the only advantage. An apparent disadvantage of such an engine is that unloading of one cylinder by, say, a blocked port will overload the other and possibly pass unobserved. Also, two coils and an enormous silencer are necessary. It has as high a cranking torque as a single and a geared starter is used instead of a dynamotor, but the maker believes that the combined unit, removal of which prevents the engine being run, is too costly in maintenance effort. The starter gear drive is engaged and the motor energised by a small lever in front of the rider. A more fundamental innovation, at least to this country, is that the engine has an automatic inlet valve.

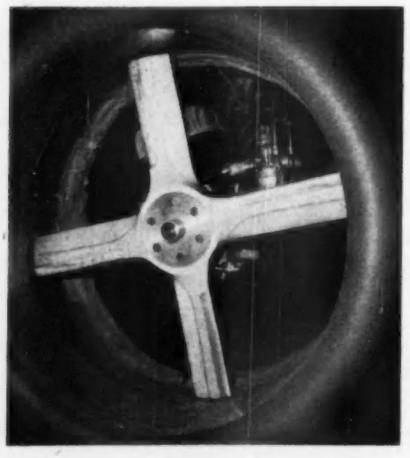
The Rhoades Hover Scooter moving forwards



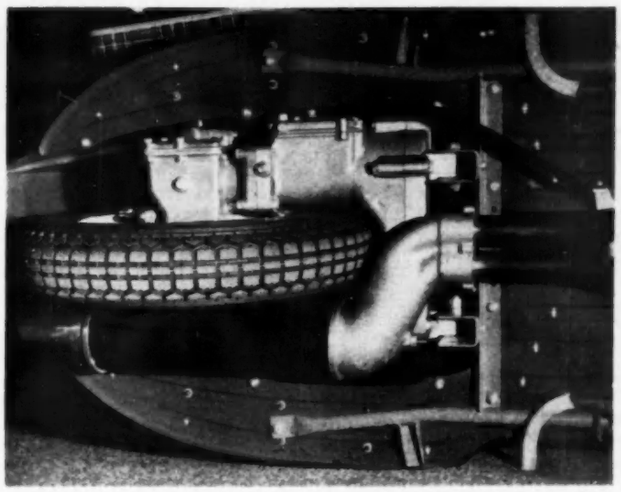
Section through Rhoades ground effect machine

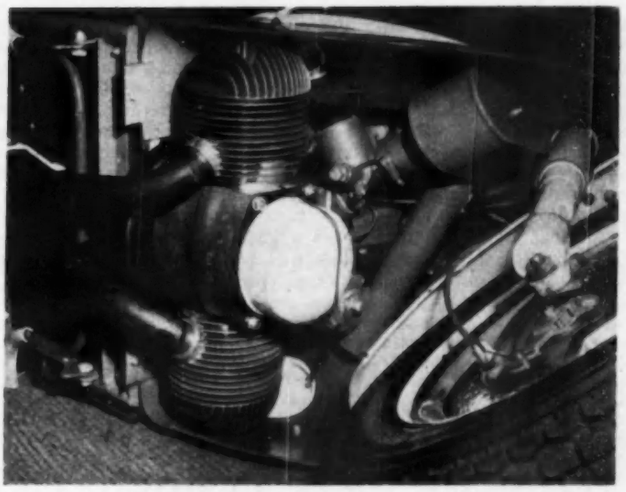
As mentioned, the power is transmitted along the gap in the " frame " by an engine-speed shaft ; this is mounted in rubber-bushed universal joints at each end and needs no attention. At the rear end the power enters the swinging arm of the rear suspension ; a duplex chain drive carries it to the starboard side. Halfway down the arm is located the four-speed gearbox, operated by a rocking pedal, and the final drive is by spiral bevel gears. It should perhaps be emphasised that while the front suspension is similar to that of the " LE " and " Valiant," the rear suspension is by swinging arm rather than swinging fork in order that a wheel can be removed from under the extensive mudguard. The machine has no lubricating nipples, bearings being either oil impregnated or packed in the factory.

Also of interest among the scooters was that exhibited by the Deutscher Innen- und Aussenhandel Transportmaschinen ; the I.W.L. " Berlin " has a footboard formed of a thick and immensely strong-looking aluminium sand-casting. Closer examination of this vehicle discloses that the whole of the cowlings are in thick aluminium sheet, so that they hardly echo when tapped, and that the entire rear body is removable in one piece. The wheels also are light alloy, of riveted construction. The mechanical design is thoroughly unconventional ; the swing fork of the rear suspension goes to the bottom ends of long horns carrying the rear hub, and the tops of these links are located by swinging links nearly parallel to the fork. The effect is therefore to generate a parallelogram linkage. Springing is by torsion bars, with a progressive characteristic developed by the rubber cushion prominent in our illustration, and telescopic hydraulic dampers are fitted. This fundamentally attractive solution to the problem of varying chain length with rear suspension travel is, we believe, novel ; compared to the discarded Ariel solution of a scissor linkage on a plunger frame, it appears to offer inherently high resistance to displacement of the wheel about the roll axis. The chain itself is, as is the practice in Germany, enclosed in rubber tunnels ; another typically Continental detail is that the light switch is worked by a key, and both this and the ignition keyholes have covers to exclude water. The detail design of this machine is in many respects worthy of study ; for instance,



The Yamaha twin-cylinder, twin-carburetter two-stroke has the cylinder-head fins in an axial plane



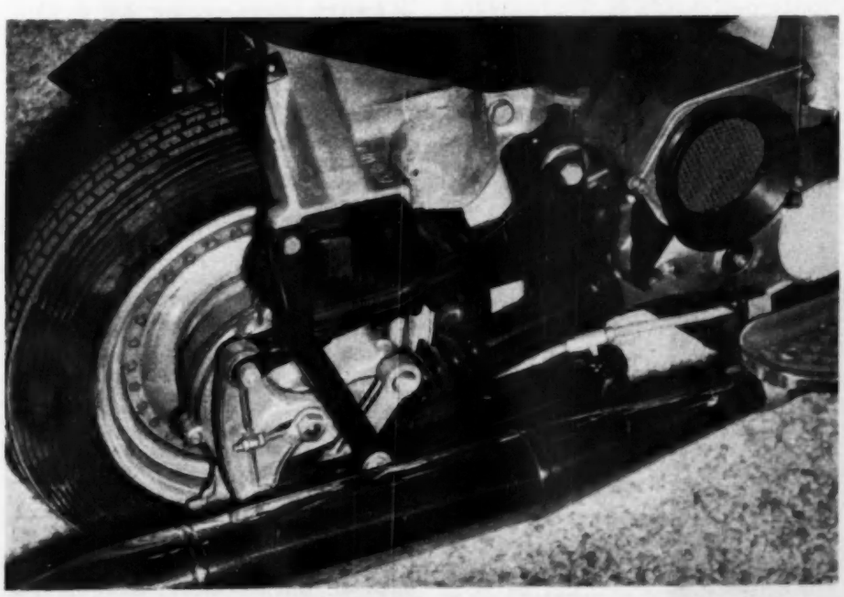


The "Viceroy" dispenses with a cooling fan by locating the engine at the front; it is a two-stroke with an automatic inlet valve. Between the generator and the air intake duct can be seen the geared starter motor. The clutch, gearbox and final drive are all enclosed in the swinging arm of the rear suspension

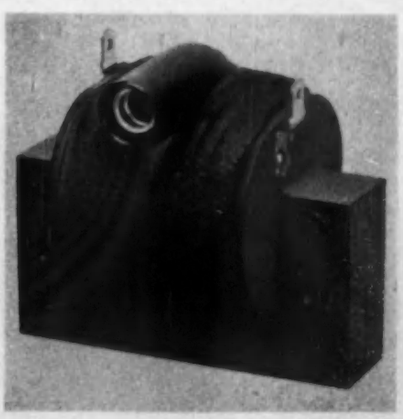
the footbrake has a cable of proportions confined to cars in this country. The ends of cables and the sliding sections of the telescopic forks are enclosed in rubber gaiters. All the grease nipples (with which both brake cables and many of the pivots are provided) have the ball valves at the extreme outside of the nipple, so that there is no recess in which dirt or water can remain after the nipple has been wiped clean. Moto Rumi, best known in this country for the "Formichino" twin two-stroke scooters in which all the main components other than the footboards are duralumin die castings, has introduced a scooter of conventional appearance, the "La Strada," in which the engine, of 98 c.c., 125 c.c., or 174 c.c., is an o.h.v. 90 deg. V-twin; this arrangement has been obsolescent for some years in this country, but is presumably the only form of four-stroke that would not compare conspicuously badly with the Rumi engines extant, on which a duodecagonal three-penny piece can be balanced while they are running. The engine is unlike the classical V-twins in having the valves in the transverse plane of the cylinders, so that a single carburetter can be used—the uneven firing order must pose acute problems of distribution—and in being in unit with the four-speed gearbox. The engine is also mounted in a light motor-cycle, which we illustrate.

Lightweight motor-cycles and sporting machines often do not carry a battery, and for such applications Joseph Lucas, Ltd., displayed their "energy transfer" ignition system. The ordinary flywheel magneto-generator has no provision for varying the ignition timing and thus compromises the performance of the engine, while the emergency starting system for machines with alternators is not only critically dependent on the spark being timed at a chosen point in the alternator cycle but also loads heavily the contact-breaker points. The new system has a solid rotor generator in which an adjoining

The 90 deg. V-twin engine of the "La Strada" has a single carburetter. In the lightness of the cycle parts the machine is typical of Italian design



The "Berlin" is built extensively of light alloy



Ignition coil with closed magnetic circuit for "energy transfer" ignition system

two of the six poles carry the alternator windings and the remaining four generate an ignition l.t. current. This highly inductive energy source is matched with a special coil in which the magnetic circuit has a closed iron path, and the result is a low contact-breaker current and the ability to provide a spark at any point in a wide portion of a half wave, the timing being variable over about 26 deg.

Another electrical exhibit was a geared starter motor shown by Siba Electric, Ltd. The normal Siba starter is combined with a generator, but for industrial engines, for instance, the generator may not be necessary and a smaller motor driving through gearing may be the best solution. The firm has therefore acquired rights in the Fairbanks Morse electric starter, which consists of a small electric motor driving into a worm reduction and, on the worm wheel shaft, a simple centrifugal friction clutch. The unit is made, apart from the motor, almost entirely of light alloy, and can be fitted on the end of a crankcase in place of a recoil hand starter.

New London Transport Underground Trains

THREE eight-car tube trains incorporating various changes in traction equipment and other details are being introduced on the Central Line of London Transport. Each train is made up of two units formed of two new motor-cars with two older trailer cars, modernised to run with the new stock, coupled between them. Although operating on the Central Line, the new trains do not set the pattern for future equipment on that route, since it was decided recently to provide the Central Line with trains of the 1959 tube stock of the kind already being delivered to the Piccadilly Line (described in our December 25, 1959, issue). They will, however, enable much operational expansion and information to be gained of new features in rolling stock and equipment design.

The motor-cars of the new trains have been built by Cravens, Ltd. They are of an entirely new design incorporating two traction motors in each bogie, instead of the single-motor arrangement used in recent London Transport stock and illustrated in our issue referred to above. As in the previous bogies, however, rubber units are used for the bolster and axlebox springing, and hydraulic dampers are fitted to limit vertical and lateral oscillations. Rubber supports from the axleboxes are also used for carrying the positive shoebeam, seen in the illustration while the negative shoebeam extends vertically downwards from the link support seen between the motor frame and the bogie headstock in the foreground of the same illustration. One end of the link is pivoted from a bracket on the motor frame and the other end is carried by a form of ball and socket joint on the headstock. With this arrangement the height of the shoe is maintained constant during vertical movements of the bogie frame with the springs. A downward movement of the frame depresses the motor nose and lifts the side of the motor carrying the shoebeam link bracket, and vice versa.

Each motor-car weighs 30 tons and has a driving position at one end. The windows in these vehicles are double the width of the usual tube stock windows, and the interior draught screens have been set back a few inches from the entrances to reduce obstruction of the doors by passengers standing with their backs to the screens.

The camshaft control equipment is of the long-established P.C.M. pattern, but has been modified for series/parallel control of two series-connected pairs of 300V motors, instead of two 600V motors. The manufacturer, Associated Electrical Industries, Ltd., has achieved this without increasing the overall dimensions of the standard equipment case used for the normal two-motor 600V equipments on tube and surface stock. The new equipment can deal with a maximum r.m.s. current of 312A, the corresponding figure for the two-motor equipment being 200A. A differential relay is associated with each pair of motors, and if voltage unbalance between the two motors in a bogie is detected as a result of wheelspin, the relay concerned opens the line breakers. The camshaft controller then returns to the " off " position, after which the equipment will notch up again automatically.

To meet increased current demands the power cables are of larger copper section, but with no additional space available the overall diameter of the cable could not be significantly increased. An alternative insulating material was therefore sought, which could have a reduced radial thickness without sacrificing dielectric strength. Several alternatives were considered to the present standard cable, which has natural rubber insulation and flameproof cotton braiding, and it was eventually decided to use a composite rubber/neoprene cable (known as R/N cable) which has a natural rubber dielectric with a neoprene sheath. Although this new cable has lower specific insulation resistance than the flameproof braided pattern, it gives a higher overall insulation resistance on a complete car because of the elimination of the flameproof braiding. In addition, the neoprene sheath is expected to have improved resistance to abrasion, ozone and oil. To obtain comparative data on the insulation resistance of complete cars and gain experience with the new cable, half the motor-cars and half the trailer cars are wired with R/N cable, and the remainder with the standard flameproof braided cable.

The traction motors (London Transport type LT.113, supplied by the General Electric Company, Ltd.) are the first 300V motors to be used by London Transport, apart from those tried for experimental purposes. They have a continuous rating of 60 h.p. at 66 per cent field. Apart from this feature, they are of the normal axle-hung, nose-suspended type. Following the practice of the 1959 tube stock cars, the nose is mounted on the bogie between resilient pads. Pinions are removable by the oil injection method. The motor leads are of a rubber/neoprene cable with an additional thickness of neoprene for mechanical protection.

The speed characteristics of the trains have been matched to those of the existing stock on the line. It has been possible as with the 1959 tube stock, to use a heavy motor field, shunted even for the lower speed characteristic, and so keep down the maximum demand for the designed acceleration. The starting current for an eight-car train is of the order of 2800A maximum, about 8 per cent less than for an eight-car train of pre-1958 stock. Overall energy consumption is of the same order as for the older stock, both stocks having approximately the same weight and performance. On the lower speed characteristic the speed is matched to that of the old stock, and a higher speed characteristic is available for possible future use on outer sections.

For the first time on modern stock of London Transport, units are fully reversible. Each of the new motor-cars is fitted with a sixty-four-stud " Wedglock " automatic coupler which has been redesigned to accommodate in the limited space available the increased number of studs necessary for reversibility.

A fundamental change has been made in the generation of low-tension supplies, which are taken from an A.E.I. motor-alternator set with an inductor alternator giving 6kW at 220V, single-phase, 850 c/s. The output to the main fluorescent lighting at 115V (feeding 4ft, 10W tubes run at 32W) is by step-down transformer. The 50V d.c. supplies for battery charging, control, brakes and doors and miscellaneous supplies are obtained from a separate winding on the main transformer, feeding a germanium full-wave bridge rectifier.

The usual 46V lead-acid battery is connected to the rectifier terminals via a smoothing choke. Emergency lighting in these motor-cars is also fluorescent and is provided by arranging to feed two of the tubes in each car from the battery through G.E.C. transistor-inverters. This has enabled emergency service to be provided without the demands on space of additional lighting fittings.

A new design of static voltage regulator has been provided in place of the vibrating carbon pattern previously used. The main transformer, rectifiers, smoothing chokes, and static regulator have been designed as a composite unit which can be removed from the auxiliary equipment case as one assembly.

The trailer cars in these trains are converted vehicles of Piccadilly Line 1927 and 1931 stock, retaining the main body structure and frame but completely renovated. Fluorescent lighting is fed from the motor-alternator on the adjacent motor-car, but 50V filament lamps are used for emergency lighting.

Two-motor bogie, showing link support for negative shoebeam between motor frame and headstock

SHORTER REPORTS

Heavy Electricals, Ltd., Bhopal

THE factory of Heavy Electricals, Ltd., at Bhopal was formally opened by Mr. Nehru at an inaugural ceremony on November 6. In this project, which will eventually produce heavy electrical equipment worth nearly £40,000,000 a year (the bulk of India's needs), Associated Electrical Industries has been closely concerned with the Indian Government. Switchgear and transformers are already being made, and before the end of the year transformers will be in production on an appreciable scale. Later heavy fabricated parts, water turbines and their associated alternators, electric motors and the electrical equipment for the electrification of India's Railways will come into production.

The scheme was originally conceived in the late 1940's, and the first positive step was taken in November, 1955, when A.E.I. was appointed as Technical Consultants and commissioned to prepare a detailed project report. After the project report had been accepted by the Central Government of India in March, 1957, the first task was the construction and equipment of a large training school and workshop where a sufficient number of artisans and engineers of all grades could be trained during the time taken to build the factory itself. At present about 3000 men are undergoing training in all the techniques of manufacturing electrical apparatus.

Concurrently with the training of artisans and junior engineers in Bhopal, more experienced engineers were sent for extended training courses, some for as long as three years, to the United Kingdom factories of Associated Electrical Industries to fit them for positions as senior engineers and factory superintendents. Ninety-seven of these men have now returned to India to make preparations for starting up production of the many departments of the factory, while another eighty-nine are still completing their training in the United Kingdom. Other senior engineers who will be required for the later phases of development at Bhopal have still to be sent to the United Kingdom during the next year or two.

While this training programme has been in operation, construction of the factory itself has gone ahead rapidly. It will eventually comprise five large manufacturing buildings 800ft long and some 600ft wide, together with the necessary subsidiary service and office buildings. Initially work was pushed ahead with the maintenance building, which was equipped with tools to provide an engineering service for the construction work. This building was commissioned in January, 1960. Next the switchgear and transformer shops were put in hand. The former building was substantially completed in June, and production was initiated there on July 1 by Mr. K. B. Mathur, the chairman of Heavy Electricals, Ltd. Machine tools, plant and manufacturing equipment are now flowing rapidly into Bhopal, some £3,000,000 worth from the United Kingdom and much from the recently established machine tool factories in India itself.

The maximum capacity of generators and transformers planned has been increased from the original 50MW to 150MW in view of the latest assessment of India's needs.

The construction work of the factory is being carried out by Indian engineers and contractors with the advice of a group of A.E.I. engineers stationed at Bhopal. This group will later be augmented by production engineers and demonstrators, who will help the management of H.E.L. to get production under way with all the precise and complicated techniques which go to the manufacture of large electrical apparatus.

At the same time a complete town to house workers, engineers and management personnel is being built, and already 3000 houses and flats are occupied. This is a good start towards the housing for the 32,000 men who will eventually be employed in the factory when it reaches its final stage. The township is being planned on modern lines with local shopping centres, schools, &c., and a central shopping and commercial area.

The cost of the factory is being met by loans from a consortium of British banks. A sum of £4,700,000 has already been made available from this source and additional loans totalling about £9,000,000 are projected, to cover capital expenditure up to 1964–65. The annual value of the output from the factory is expected to rise from about £3,000,000 in 1962 to about £9,000,000 in 1963 and about £20,000,000 in 1964–65.

Commonwealth Telecommunications Report

THE ninth general report of the Commonwealth Telecommunications Board, covering the period January 1 to December 31, 1959, records progress in several schemes for extensions to United Kingdom radio stations. Four new 30kW independent sideband transmitters were installed at Dorchester, and thirteen other transmitters at this station were due to be in service by the middle of this year. Plans went forward for a new building at Leafield to have six 100kW transmitters for press services and twelve 30kW transmitters mainly for multi-channel telegraph services. A new aerial system will be provided. Work began on modernisation at the Somerton aerial system, where the existing Franklin arrays are to be replaced by fifteen diversity pairs of two-unit reversible rhombic aerials. On the Cooling receiving station site, installation began of an experimental section of a multiple-element directional universally-steerable aerial comprising ninety-six unit aerials.

Assurance has been given by the Canadian National Body that sufficient circuits could be made available in the Trans-Canada microwave system for Commonwealth traffic in transit through Canada, in the event of deterioration in radio conditions on the United Kingdom-Australia and United Kingdom-New Zealand direct radio circuits.

The Australian national body reports the conversion of radiotelegraph circuits between Melbourne and London to five-unit operation using error-correcting multiple equipment. Similar apparatus was introduced in the Wellington-Vancouver-Montreal telegraph service of the New Zealand Post Office, one channel of which is now dispatched through to London at Montreal for a certain period daily. This route via Montreal now forms the main radiotelegraph route from New Zealand to the United Kingdom. Five radiotelephone terminals were installed at the Kirkee transmitting station of the Indian Overseas Communications Service and further progress was made in converting radiotelephone circuits from double-sideband to single-sideband. Only two of the fifteen radiotelephone services operated from Poona remained double-sideband at the end of the year. In Ceylon a twelve-channel v.h.f. link was in course of installation between Colombo central telegraph office and the radio stations at Pothode and Kadirana.

British Shipbuilding Research Association

AT a recent extraordinary general meeting of the British Shipbuilding Research Association, Sir James Milne, the chairman of Council, disclosed that the new terms of grant aid offered by the Department of Scientific and Industrial Research for the next three years are £60,000 per annum from the Department to be set against £300,000 raised by the industry, compared with £50,000 received per annum during the last five years and provided that the industry's share was £150,000. Expenditure throughout the Association's existence had steadily risen and the total reached £277,000 in 1958–59 and £330,000 in 1959–60, while the expenditure in the 1960–61 period is estimated to amount to £435,000 including £142,000 on extra-mural research. Sir James expressed the hope that the D.S.I.R. might increase its contribution in the next period since research must go forward during difficult times. The need for additional staff to maintain the expanded research programme has put a premium on space and to solve this problem he said that a lease has been taken of Prince Consort House, on the Albert Embankment. This is a new building which is expected to be completed by the end of November.

Sir Charles Connell, the chairman of the research board, commented upon the progress of research and noted that thirty-six reports had been approved, while as a result of a review of the research programme it now covers 103 items. He referred to the extension of the methodical series tests on ocean-going merchant ship forms up to 0·85 block coefficient and to tests covering bow and stern variations of forms of 0·80 block coefficient. Stress data on ships' structure in service continues to be collected and it is recorded that a light alloy superstructure on a liner proved 80 per cent effective in contributing to the main hull girder strength when stresses were measured during launching. Sir Charles noted the work at Glengarnock and the investigations into sound insulation and hull vibration, and that progress is being made in the study of the laws of natural circulation in watertube boilers, aided by the use of radioactive isotopes for measuring the density of the steam-water mixture in the riser tube. Other research items noted concerned firebricks, stresses in steam pipes, noise measurements in free-piston machinery, scavenging and super-charging of two-stroke engines, and the matching of exhaust gas-driven turbo-chargers. An ultrasonic method of measuring torsional rigidity of propeller shafts has been developed, as has also a transient torque recorder, and Sir Charles, in his review of the research programme, also mentioned acceleration tests on a 50,000 tons deadweight tanker, for measured mile procedure, hull roughness tests and investigations into seakeeping qualities.

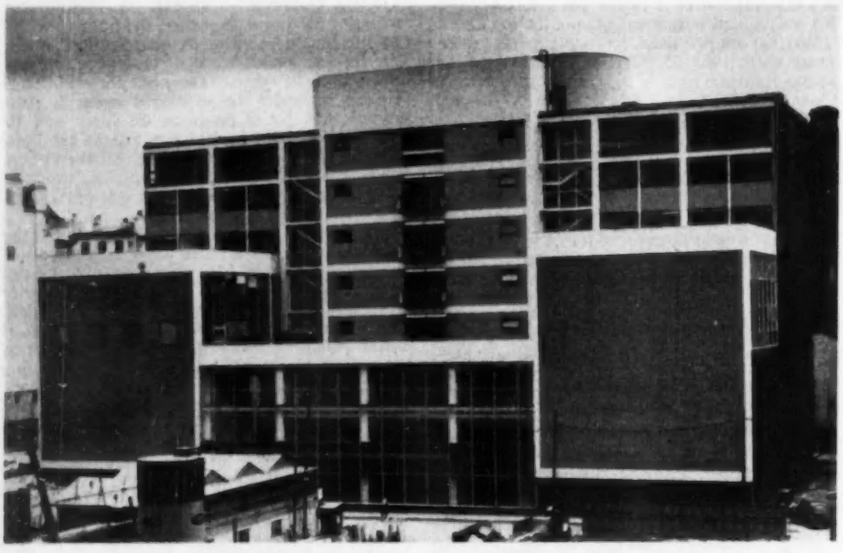
Physical Society Exhibition, 1961

As a result of the recent amalgamation between the Institute of Physics and the Physical Society, the Physical Society Exhibition of Scientific Instruments and Apparatus will be known as the Annual Exhibition of the Institute of Physics and the Physical Society. The exhibition will be held from January 16 to 20 next year at the Royal Horticultural Society's Old and New Halls, Westminster, S.W.1. Discourses (demonstration lectures) will be given on the following days at 5.45 p.m.: January 17, "Hydrodynamic Research," by F. S. Burt (Admiralty Research Laboratory); January 18, "The Physics of the Oceans," by Dr. G. E. R. Deacon (National Institute of Oceanography); January 19, "Some Physical Problems in Travelling at Supersonic Speed," by Dr. F. P. Bowden (Laboratory for the Physics and Chemistry of Solids, University of Cambridge). Tickets are available from the Institute of Physics and the Physical Society, 47, Belgrave Square, London, S.W.1.

SHORTER REPORTS *(Continued)*

New Imperial College Building

RECENTLY the first part of the new Engineering Building at the Imperial College of Science and Technology was formally commissioned. The old building of red brick on Exhibition Road was brought into use in 1884; while there were 200 students when the City and Guilds College became part of Imperial College in 1907, there were nearly 800 in 1952 (by which time a separate building housed chemical engineering) and there are now more than 1250; the figure is expected to rise to 1750 in the course of the expansion of Imperial College. The new building will accommodate 350 students of mechanical engineering and will form the eastern boundary of a quadrangle defined on the south and west by buildings now under construction for the civil and electrical engineering departments respectively. The building is of nine floors (compared to five, including a basement, in the original building) and transit is by lifts. Designed by Messrs. Norman and Dawbarn, it is of composite construction with structural steel and reinforced concrete frames. External treatment is similar to that adopted for the new building for the Physics Department (opened last month by Sir John Cockcroft)—white mosaic columns and spandrel walls faced with green Swedish tiles.



New building of the City and Guilds (Engineering) College

Centenary of the Fairfield Shipbuilding and Engineering Company, Ltd.

To have completed 100 years of shipbuilding and marine engineering and to have weathered the economic storms of the inter-war years is an indication that the Fairfield Shipbuilding and Engineering Company, Ltd., was built upon a sound foundation. To record this achievement the company has recently published a book which traces the progress made and describes and illustrates some of the more outstanding ships built and engined during the century just completed. Actually, according to the record, the company's beginnings, although concerned with engineering, were not associated with marine engineering for on September 30, 1834, work began on the building of a small engine shop in Centre Street, Glasgow, with no thought that such a small business would eventually rank among the foremost shipbuilding and engineering companies.

Within a few years the firm had acquired considerable goodwill as millwrights and then was strengthened in 1852 when Mr. John Elder joined the firm, bringing with him a wealth of technical knowledge of and practical experience in engineering. He was responsible for the design and construction of a compound steam engine and his interest in marine engineering soon turned the firm's attention to that category of engineering, and a set of compound machinery was built in 1854 for the local steamer "Brandon." Within a few years of completing this unit of small power the company advanced rapidly to building propulsion machinery for ships of the Pacific Steam Navigation Company. Having become established in the business of marine engineering it was but a short and logical step to complement the building of engines with the building of hulls, and in 1860 the order for the company's first ship, the "Macgregor Laird," a passenger vessel of 966 gross register tonnage, was received from the African S.S. Company. This, the first of a long line of orders, was built at Napier's old yard at Govan, but it was early evident that a larger establishment was necessary, and Mr. Elder, in 1864, acquired Fairfield farm, the present site of the works, and proceeded to build a shipyard and engineering shops to his own layout. Meanwhile he was engaged in the advancement of marine engineering and invented a watertube boiler, paddle floats, triple and quadruple expansion engines, surface condensers, a system for heating feed water with waste gases, and many other allied projects. John Elder assumed sole control in 1868 but died the following year without seeing the fruition of his plans. However, his name is perpetuated in the John Elder Chair of Naval Architecture, in the University of Glasgow, which his widow endowed in his memory.

Those were the beginnings, as recalled in the centenary volume, and since then the first ship has been followed by over 800 naval and merchant ships, having a total tonnage of more than 2,000,000 tons gross, and machinery developing 7,000,000 h.p. has been built.

The building of the yard at Govan was completed in 1871 and some years later William Pearce took over control and by his dynamic personality and many activities made the name of Fairfield well known. He it was who commenced building fast Atlantic liners, the "Arizona," built in 1879, being his first record holder, and was also active in the construction of high-speed cross-Channel ships, producing the paddler "Victoria," in 1886, capable of crossing from Dover to Calais in one hour. After the death of Sir William Pearce the firm became a public company with his son as chairman, and he was followed in 1907 by Dr. Francis Elgar, the first to occupy the John Elder Chair of Naval Architecture, and in 1909 by Alexander Gracie. There was a change of control after the first world war and the firm, with orders for Canadian Pacific, Anchor and Donaldson liners, was adequately employed during the nineteen-twenties, but passed through a difficult period in the next decade, and it was in 1935 that Sir James Lithgow and his brother took over the company, to begin a new era in its history. With the conclusion of the second world war came the need to revise construction techniques and procedure and to replan the shipyard. These schemes have been carried out in stages during the last few years and the completion of the century marks a point where the old workshops have disappeared, fitting-out shops have been re-organised, berths have been re-sited and the replacement of the steelworking shops put in hand so that a new, functional, and efficient yard is emerging under the chairmanship of Sir John Erskine and forming a member firm within the Lithgow group of companies. Of engineering activities, the book calls attention to the company's extensive research into the development of turbine reduction gearing design and gear cutting techniques, the building of Doxford, Sulzer and Stork diesel engines, and also the company's interest in nuclear propulsion in association with Mitchell Engineering, Ltd., and Combustion Engineering Inc., of New York. The centenary volume includes a note upon the activities at Chepstow and lists the warships and merchant ships built by the company in its 100 years of existence.

Self-Contained Fire Alarm

A BATTERY-OPERATED fire alarm has been introduced to this country by Fire Cry-er, Ltd., Jack Bridge Mill, Colden, Hebden Bridge, Yorks. The alarm takes the form of a continuous scream audible up to 1000ft in still air and able to penetrate throughout any private house. The detector is a bi-metal strip which responds at 135—140 deg. Fah; while the batteries and the siren can be tested by pressing a button on the casing, the sponsors point out that the detector can be tested with a home hair-dryer. By locating the alarms at carefully chosen points, it is claimed that early warning of a fire anywhere in a house can be obtained with a few, perhaps three, units. The batteries, if "leak proof," will last for at least a year and give a continuous alarm for an hour. Resetting is inherent with fall of temperature.

[Reply Card No. E8463]

This audible warning of high temperatures is battery-operated and needs merely to be hung up in a building

Shielded Arc Welding and Flame Cutting Equipments

AT an exhibition of "Rowen-Arc" welding equipment organised by Rubery Owen and Co., Ltd., Darlaston, Wednesbury, Staffs, and held in Birmingham recently, there was demonstrated the range of American Westinghouse arc welding equipment the firm is now making under licence. This was the first of a series of exhibitions the firm is to hold in various parts of the country, and it was organised in conjunction with the Midlands Electricity Board in whose show rooms the demonstrations were given.

In addition to demonstrating the "Rowen-Arc" gas-shielded, metal-arc, consumable electrode welding equipment for the semi-automatic

Mobile equipment for automatic and semi-automatic gas-shielded, consumable electrode welding

argon-arc welding of aluminium and CO_2 welding of mild steel, the "Port-Arc" portable welding set shown in our illustration was exhibited. This equipment is quickly and easily adapted for the semi-automatic and automatic welding of mild steel and aluminium and for automatic spot, plug and tack welding. The demonstrations included CO_2 shielded arc welding of $\frac{1}{8}$in mild steel plate, spot welding two $\frac{1}{8}$in steel plates and spot welding 18 gauge sheet to $\frac{1}{8}$in plate.

The equipment is a completely self-contained unit mounted on a three-wheeled chassis, with stands for two gas cylinders at one end, and ready for coupling up to a 380V to 440V, three-phase power supply. The power unit is rated at 500A at 100 per cent duty cycle and is designed to produce the relatively flat volt-ampere characteristics required for maximum arc stability in automatic or semi-automatic welding. It has a built-in primary contactor, pilot relay and a 110V, single-phase, 60 cycle auxiliary transformer.

The control cabinet, to be seen at the top of the rear assembly on the carriage, incorporates a single thyratron electronic tube and operates from the 110V a.c. supply mentioned above. The wire feed rolls mounted at the rear of the cabinet are driven by a $\frac{1}{12}$ h.p. d.c. geared motor at a constant preselected speed under all loads. An adjustable mechanical brake on the reel hub is set to maintain a uniform wire tension. A timer mounted on the cabinet door is adjustable from 8 to 360 cycles to set the weld interval when plug or spot welding. An adjustable inching speed control also mounted on the cabinet door provides means of automatic purging of gas and water lines prior to the initiation of each welding time. A three-position switch is used to set the equipment for automatic, semi-automatic and automatic plug or tack welding. A 40-gallon water tank mounted in the frame below the control cabinet provides sufficient coolant capacity for the heaviest duties and water is circulated through the system by a motor-driven pump, to which power is supplied from the auxiliary transformer.

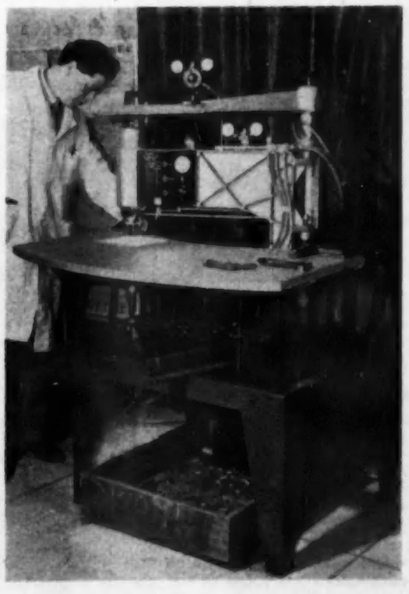
The welding gun provided is of lightweight plastic construction primarily designed for semi-automatic operation with up to 500A. It has a built-in wire feed speed control, a start and stop switch and an inching button. Its quickly interchangeable electrode guide tube is self-centring on clamping and can be used until almost its full length is consumed. For plug and tack welding operations two types of nozzles, one air- and the other water-cooled, can be fitted on the gun to adapt it for flat, inside corner or outside corner welding. The air-cooled nozzle is designed for short run work and the water-cooled design for long run work producing identical welds.

Another piece of equipment demonstrated at the exhibition was the Swiss-built "Rowen-Gloor" flame cutting machine which we also illustrate on this page. This machine is designed to cut mild steel plate from $\frac{1}{8}$in to 4$\frac{1}{2}$in thick up to 75in long by 28$\frac{1}{2}$in wide using templates, or 40in long by 20in wide using drawings on the guide table; a compass attachment enables circular cuts up to 27$\frac{1}{2}$in diameter to be made. A "U"-shaped assembly supports the guide head above the table and the flame cutting head on the same vertical centre line below the table. The arm is hinged on an intermediate arm pivotally supported on the rear pillar of the machine.

When using a template for repetition work the template is secured over the guide head at the end of a beam projecting from the top of the pillar. A magnetic drive roller at the top of the guide head is registered on the template profile and automatically follows its shape to steer the cutting head round the workplate supported on the cross members of the machine base. The magnetic roller drive can be reversed so that the direction of cutting head travel can be selected in accordance with workpiece shape and size.

When it is required to cut individual shapes to a drawing, the drawing is fixed on the table of a machine and its outline traced with a pin at the side of the guide head; for this tracing operation a serrated roller projecting from the guide head is lowered into frictional contact with the table. The roller is driven through a clutch and can be turned by fingertip pressure by the machine operator as cutting proceeds to follow the lines on the drawing. With this form of driven follower the operator can, without effort, trace the shape on the drawing easily and accurately.

Parallel guide links built into the hinged arm assembly enable straight cuts to be made automatically in any preset direction across the tracing table. Using this mechanism in conjunction with an inbuilt locking lever when tracing drawings by hand, right angle changes in direction can be made instantaneously to flame-cut accurate square corners on the workpiece. Through its supporting spindle the guide wheel has a shor vertical free movement to compensate for any possible unevenness of the table surface and ensure a constant contact pressure of the wheel on the table.



Flame cutting machine for single or batch cutting mild steel from $\frac{1}{8}$in to 4$\frac{1}{2}$in thick

The controls of the machine are grouped as a panel incorporated in the guide arm and the three control valves for the gases are located at the top of the inner end of this arm. Normally the machine is designed for operation with oxy-acetylene but oxy-propane, oxy-coal gas and -hydrogen can also be used for flame cutting. The fuel gas and oxygen are conveyed separately to the cutting torch where they are mixed and four interchangeable nozzles are supplied with a machine. A potentiometer built into the control panel gives a stepless range of cutting speeds which are indicated on a tachometer at the side.

[Reply Card No. E3471]

Wheeled Carriages for Crane Outriggers

To increase the scope and use of truck-mounted and self-propelled cranes, Steels Engineering Products, Ltd., Sunderland, has introduced a design of wheeled carriage for crane outriggers. Telescopic outriggers and screw jacks, which are necessary with practically all but the smallest self-propelled and truck cranes to obtain maximum lifting capacity, prevent further chassis movement of the vehicle and limit the usefulness of a crane when lifting maximum loads.

The new wheeled outrigger carriage, to be seen in the illustration, is designed to permit forward

Carriage fitted on mobile crane outrigger to impart mobility when handling heavy loads

and reverse movement of a crane with the outriggers extended and with a heavy or even maximum load on the hook. The carriage consists of a rocking beam suspension bogie which is mounted on each of the four crane outriggers to replace the usual blocks or packing. Each bogie has two rollers fitted with solid rubber tyres.

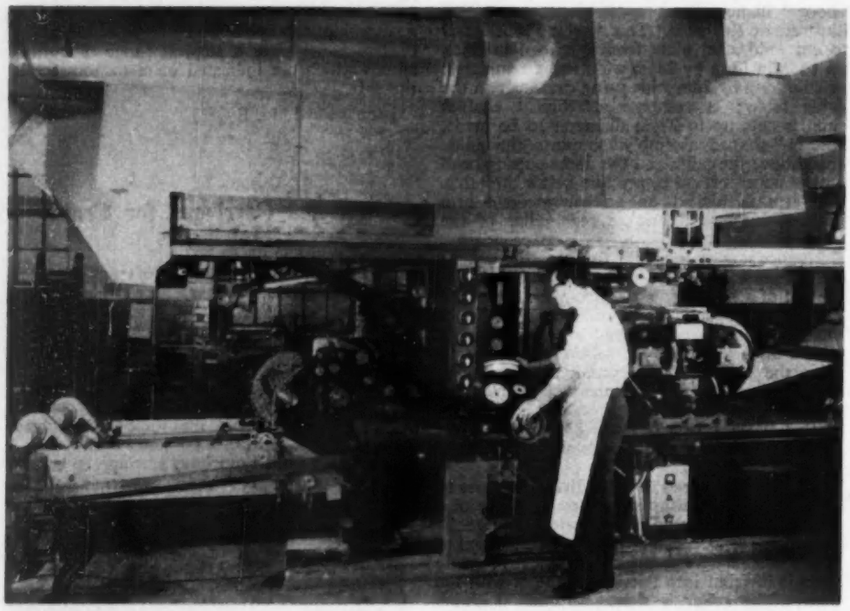
This equipment can only be used on a reasonably level, well-made road, but it is stated to make available to a crane of up to 25 tons capacity, in a mobile condition, duties which would normally be possible only by the use of blocked stabilisers.

[Reply Card No. E8472]

SHORTER REPORTS *(Continued)*

Improved Braille Printing

THE normal method of printing Braille characters is to emboss them, distorting the fibres of a special paper to form hollow dots in the required pattern. This has several disadvantages. The paper has to be rather thick, and the printed matter is heavy and bulky. Embossed dots become worn during touch-reading by the blind, and are liable to be damaged by crushing during transport and storage. These disadvantages are overcome by the solid-dot method of printing Braille, developed by the Royal National Institute for the Blind, and now in use at its headquarters, 224, Great Portland Street, London, W.1. In its essentials the solid-dot process is simple. Dots of plastic ink are printed in the required pattern on the surface of thin but strong paper, and the ink dots are cured by passage through a heating chamber. The resulting printed Braille pattern is much better able to withstand wear and handling than the embossed type, and, since a lighter paper can be used, the printed matter is much lighter and less bulky.



Solid dot printing machine. The stencil drums are immediately to the right of the operator

The machine for solid-dot Braille printing was designed and built by Chambon (Park Royal), Ltd., 8, Chase Road, London, N.W.10, in conjunction with the Royal National Institute for the Blind. It produces untrimmed, folded, sixteen-page sections suitable for collating, stitching and trimming into magazine or book form. Kraft paper of 28 lb substance is processed continuously from 3ft diameter reels at approximately 110ft per minute. The Braille dots are formed of a special P.V.C. paste, applied under pressure to both sides of the paper through a set of sixteen perforated stencils fitted round two contra-rotating drums. Zinc sheeting 0·010in thick is used for the stencils, which are perforated on a special-purpose transcribing machine, a paper embossed copy being produced simultaneously to facilitate proofing. Correction of errors is carried out on a machine which pierces additional holes or obliterates by spinning any which are not required ; the paper proof is corrected at the same time as the stencil.

Printed paper passes from the stencil drums through a gelling chamber, where it is heated to approximately 200 deg. Cent. It is subsequently cooled by cold air jets and then passes to fan-folding and delivery mechanisms ; from this point onwards the machinery is of orthodox form.

In designing the printing machine several problems had to be solved. " Welvic " P.V.C. paste, made by Imperial Chemical Industries, Ltd., has proved quite satisfactory as the material for the dots, but its viscosity makes it difficult to pump. This difficulty has been overcome by using a " Mono " pump, which lifts the plastic from the 5-gallon containers in which it is received, and discharges it to the machine hopper feed. Because the gelling temperature of the plastic is near the flashpoint of the paper, the heating chamber had to be specially designed to prevent the paper from catching fire and, in case of accident, to confine the fire to the chamber itself. The heating chamber is of G.E.C. design, with two infra-red sheathed wire element heating panels.

It was found that considerable static electricity was present in the paper after printing, and static eliminators are fitted in the cooling equipment on the delivery side of the heating chamber. Cleaning of the stencils is effected by nylon rotary brushes revolving against doctor rollers running in plasticiser. On the feed side of the machine there is a photo-electric cell to detect joins in the paper. Joins would affect adversely the reading properties of the printed sheet, and the photo-electric cell operates an automatic spray of quick-drying ink on the join ; this enables collators to discard the affected section.

[Reply Card No. E6481]

Research and Industrial Polarograph

WE illustrate the Tinsley polarograph, Mark 200, manufactured by Evershed and Vignoles, Ltd., Acton Lane, London, W.4., for research and industrial requirements. Its field of application covers investigations into electro-chemistry, stability constants of reducible compounds and characterisation of certain complex organic materials. The polarograph is capable of trace determination of materials in solution to better than 0·02 p.p.m.

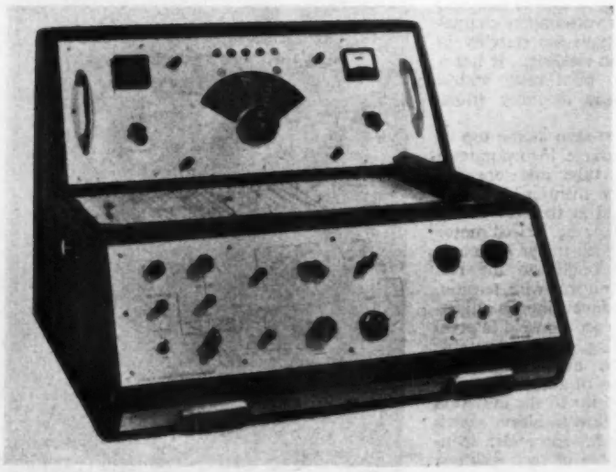
Polarograph analysis makes use of the phenomenon that if the potential applied to certain special forms of electrode immersed in a solution is varied, the current flow to a second electrode, serving simply as an anode, follows a definite pattern according to the nature of the solution. The active electrode may be of various forms, one of which is the dropping mercury electrode consisting of a regular series of small mercury drops formed in the solution at the end of a fine-bore glass tube. The behaviour of such an electrode at any time thus does not depend on its previous history.

The d.c. circuit used in the Mark 200 polarograph allows operation from electrode systems such as dropping mercury electrodes, vibrating and rotating solid electrodes, or pool electrodes. A newly designed galvanometer transistor d.c. amplifier is incorporated. The recorder on which the final polarograms appear presents the trace on a horizontal table on which the operator may write the relevant experimental data. Indicators for voltage and sensitivity are arranged at eye level, and controls which are kept at the same setting throughout a series of experiments are arranged below the recorder table.

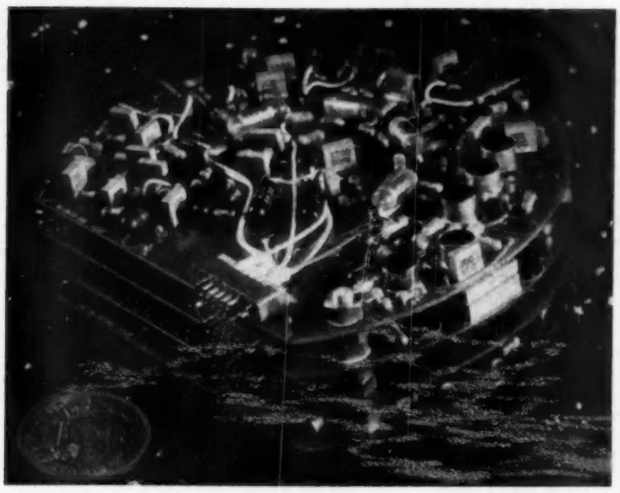
The potentiometric recorder has an effective chart width of 200mm and a response time of one second. It embodies an integral amplifier. Two chart speeds are provided. Overall sensitivity of the polarograph is from 0·02–100 micro-amperes for full scale deflection.

A peak reading unit (the subject of a patent application) is incorporated, which eliminates capacity current noise from the normal dropping mercury electrode and thus permits the chemist to obtain virtually undamped polarograms at all sensitivities without loss of resolution on both direct and derivative polarograms. Conventional damped polarograms may also be recorded.

[Reply Card No. E8482]



Polarograph with horizontal -table potentiometric recorder



Transistorised X-ray spectrometer for installation in the "Scout" satellite. The card modules are of 5½in diameter

X-Ray Spectrometer for Satellite

ELECTRONIC equipment for one of the experiments to be carried out by the first Anglo-American "Scout" space research satellite, planned to go into orbit next year, has been designed and manufactured by the Guided Weapons Laboratory of Bristol Aircraft, Ltd. The equipment is an X-ray spectrometer developed for the Space Research Group at University College, London, and the Physics Department of the University of Leicester, which will be used in an experiment to obtain data for the correlation of ionospheric behaviour with solar X-radiation outside the atmospheric shield of the earth.

The spectrometer measures the rate of incidence of X-rays in five energy bands within the range of 2 to 13Å. X-rays are detected by a proportional gas counter which produces pulses of heights proportional to the energies of the incident X-rays. Minimum pulse separation is one microsecond. The pulses are amplified by about 72dB in a low-noise, stable-gain amplifier and are then sorted into five energy bands by a pulse height discriminator. The five bands are interrogated sequentially by a gate which is controlled by the master clock in the satellite. Each band is interrogated for a period of one second during each cycle of operation. The pulses occurring during each interrogation period are accumulated in a fifteen-stage binary counter. At the completion of each count, the contents of the counter are transferred direct to the telemetry system for direct transmission to the ground while the vehicle is in contact with ground stations, or for storage on a magnetic tape, so that it can be read when contact is made again.

The equipment is fully transistorised and is designed to operate on less than 100mW derived from the solar cell power system in the satellite. The interior electronic equipment as a whole, including the spectrometer, is constructed in 5½in diameter circular cards or modules. The Bristol Aircraft package (illustrated), comprising four modules encapsulated in polysulphide rubber and foaming resin, is no more than 3in in depth.

Traffic Survey for Dartford—Purfleet Tunnel

THE origin-and-destination traffic survey conducted by the L.C.C., prior to the resumption of work on the Dartford—Purfleet road tunnel, provided the subject for discussion by the Traffic Engineering Study Group of the Institution of Civil Engineers on October 27. The subject was introduced by Mr. F. A. Rayfield, M.I.C.E., deputy chief engineer, London County Council; Sir George McNaughton was in the Chair.

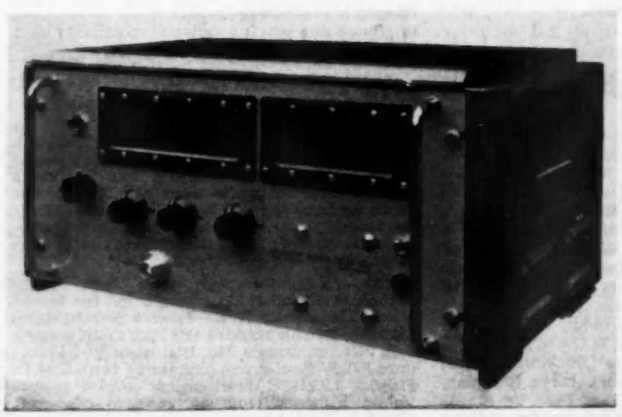
From the estuary upstream to London the existing sequence of Thames crossings for road vehicles is: Gravesend–Tilbury ferry; Woolwich ferry; Blackwall tunnel; Rotherhithe tunnel; Tower Bridge. The Dartford–Purfleet tunnel is being driven under Long Reach, approximately midway between the two ferries, 10 miles downstream of Blackwall tunnel. The survey, which took place in 1953, established that the tunnel would attract sufficient toll traffic to justify the estimated £10,000,000 outlay on tunnel, approaches, and link roads. The project was of long standing, having been suspended in its earliest stages, when war came.

The survey was made on two days, a Sunday and a Tuesday, in July, at the five crossings already named and at Vauxhall Bridge as a western check point. Mr. Rayfield described the roadside procedure, the subsequent plotting and classification of journeys, and the final calculations to determine how many vehicles would be attracted to the new tunnel for reasons of economy. The conclusion reached was that, on the volumes surveyed, some 3700 private and 2700 commercial vehicles would probably use the tunnel every working day.

Typical of the many points that arose in the discussion, bringing out the wide choice of methods open to traffic surveyors, was the selection of the system of sampling for use on routes too heavily trafficked for the checking of every vehicle, such as the tunnels and bridges in in this survey. On the original survey the sample rate was 20 per cent, reducible to 10 per cent when inordinate delay occurred; but when the survey was repeated in May, 1960 (in order to revise the prospective scale of toll charges), the traffic was allowed to keep on flowing until the interrogator was ready to accept his next vehicle, with the result that the sampling rate varied from one in three at slack times to one in fifteen at the rush hours. There were claims for the superior trustworthiness of both methods; the group left it as a practical matter of balancing simplicity of outdoor work against complexity in expanding the recorded figures.

Among the facts revealed by the second survey was a 9½ per cent per annum compound increase in private car traffic. The pre-war estimated toll of 2s. would now be at least doubled and might be trebled. It was estimated that the diverted traffic would load the tunnel to 50 per cent of its capacity. Some figures were quoted relating to the capacity of tunnels of comparable length and cross section (though with carriageway 3ft wider—24ft vice 21ft) on the Pennsylvania Turnpike: peak daily flows exceeded 30,000 vehicles; the greatest count in a single hour was 2346; in either direction the maximum flow varied between 1000 and 1400 v.p.h., depending on the weather and the proportion of commercial vehicles (normally 17 per cent); the average critical flow, at which a queue would begin to form at the tunnel mouth, was 1250 v.p.h. at 35 m.p.h. (i.e. road space 49 yards per vehicle). The opinion was expressed that these figures confirmed that the capacity of the Dartford tunnel had not been over-estimated.

Details of the organisation of the survey provided many points for discussion; the L.C.C. has not published anything on it, but its records are available to supplement the existing literature on traffic surveys if required. Among the broader issues discussed there arose the question of the tunnel's effect on the distribution of industry and population in Kent and Essex: the Mersey tunnel had contributed greatly to the development of Cheshire; what development would result from this tunnel? But, it was pointed out, the survey had had only a limited aim; vastly more data would need to be collected before a wider study, on the long-term effects, could be begun; possibly some of the necessary data would be forthcoming as a result of the impending London traffic survey, which survey would be a "gargantuan" task, said one speaker, in the light of his experience on this comparatively modest tunnel survey. He thought the London survey could hardly be mounted in time to start before next spring.



Resistor test set with digital display of nominal value and deviation therefrom

Resistor Test Set

THE EM1006 resistor digital test set illustrated has been introduced by Solartron Laboratory Instruments, Ltd., Cox Lane, Chessington, Surrey, to permit rapid and accurate measurement by unskilled personnel of the percentage deviation of a resistor from its nominal value. A Wheatstone bridge circuit is used, and is set up so that the bridge will balance if the resistor is of its nominal value. A digital display of the selected value is presented to the operator. If the bridge does not balance when the resistor is inserted, one arm is adjusted in a binary step logic to detect the sense and extent of the error, both of which are digitally indicated and may also be printed out. The command to digitise can be derived in one of three ways: manually, internally at repetition rates variable from one second to ten seconds, or by remote contact closure.

The reading time of the machine is 0·2 second per resistor; thus, if it is used in conjunction with a printer, a maximum rate of five resistors per second can be recorded. The tester will handle resistors from 10Ω to 15·9MΩ and the maximum indicated deviation is ±9·9 per cent. Accuracy and stability are guaranteed to be better than 0·1 per cent.

[Reply Card No. E8493]

SHORTER REPORTS *(Continued)*

Definite-Time Earth Fault Relay

A SENSITIVE d.c. polarised relay, CMU, designed to protect medium-voltage overhead lines against earth faults, by operating for very low values of current, has been introduced by The English Electric Company, Ltd., Strand, London, W.C.2. It is specially intended for lines (at voltages such as 6·6kV, 11kV and 33kV) carried on wood poles without earth wires, where experience has shown that Mho relays and inverse time overcurrent relays may fail to give protection on those occasions when broken poles result in high-resistance earth faults. We learn that the relay has had extensive field trials with the Midland Electricity Board.

The CMU relay incorporates a VAT timing unit to give a definite and adjustable time delay, which ensures that the relay does not trip the circuit breaker until the main earth-fault protection has had time to disconnect the faulty section. By the inclusion of a saturable current transformer to protect the sensitive measuring element against large fault currents the CMU relay is given a suitably high thermal rating. In addition, the use of a polarised relay confers immunity against spurious operation resulting from mismatching in the main line current transformers.

The CMU relay is fitted in a single-pole drawout case. The measuring element is a sensitive polarised relay, type CMG, fed with the rectified output of a saturable current transformer which draws earth fault current from the main line current transformers CT (Figs. 1 and 2).

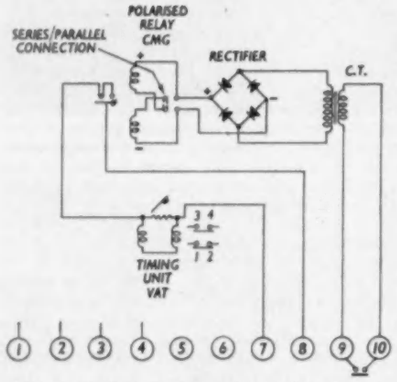


Fig. 1—Earth fault relay CMU self-reset type

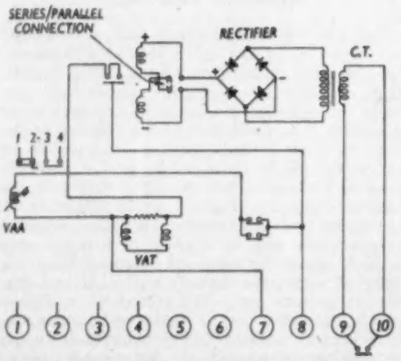


Fig. 2—Earth fault relay CMU hand-reset type

Closing of the polarised relay contacts operates a timing unit VAT.

Two forms of the relay are available. In the first, which is self resetting (Fig. 1), two normally-open self-reset contacts are fitted on the timer unit for use in the tripping and alarm circuits. Operation of the relay is indicated by a mechanical flag on the timer.

In the second form (Fig. 2), which is reset by hand, the timer operates an auxiliary unit VAA, which has one normally-open self-reset contact to energise the tripping circuit and one normally-closed hand-reset contact for blocking auto-reclosure. Operation of this relay is indicated by a mechanical flag on the auxiliary unit.

The relay has a minimum setting of 0·1A which is equivalent to a setting of 2 per cent of normal full load, with current transformers having a secondary rating of 5A. As the burden imposed on the current transformers by the relay is very small the effective primary setting is almost equal to the actual relay setting. When the CMU relay is used on the same current transformers as other kinds of protection the setting depends to some extent on the total burden connected to the relay. As indicated in the diagrams (Figs. 1 and 2) the polarised relay has two coils which can be connected in series or parallel through links in the back of the relay assembly. A setting of 0·1A is obtained with the coils in series ; the parallel connection can give a pick-up current of about 0·15A.

The thermal rating of the relay varies from 100A for ten seconds up to a maximum of 200A for 2½ seconds. The relay burden is 0·005VA at pick-up. In both the self-reset and hand-reset relays the contacts are rated to make and carry continuously 1250W with current and voltage maxima of 5A and 660V d.c.

The timer, which can be seen in Fig. 3, is

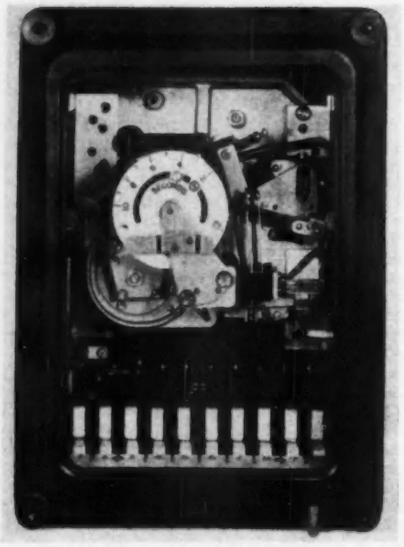


Fig. 3—Definite-time earth fault relay

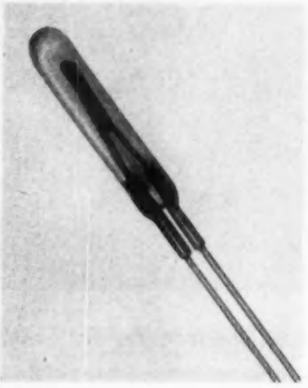
scaled from two seconds to ten seconds delay on pick-up, the interval being infinitely adjustable ; drop-off is instantaneous.

[Reply Card No. E8501]

Photovoltaic Light Sensors

Two silicon light-sensor devices are being manufactured by Texas Instruments, Ltd., Dallas Road, Bedford. One of these, LS221, is a null-sensing device consisting of two matched sensors connected so as to give a null indication when an equal amount of light falls on each sensor. When positioned behind a moving pointer or in front of a moving beam of light, the LS221 can indicate remotely minute variations of light intensity and therefore of pointer or beam movements. It is housed in a subminiature case only 0·44in long and is expected to find a wide field of use in such applications as photo-mechanical tracking systems, servo systems, gravity meters, curve followers, galvanometers and so on.

The LS222 is a horizontal light sensor designed specifically for punched card and tape readers. It is housed in a subminiature glass case 0·50in



Enlarged view of diffused junction silicon light sensor for punched card and tape readers. Actual size of the subminiature glass case is 0·5in long by 0·08in diameter

long by 0·08in diameter and produces an output of over 250 microamperes with a 1000-ohm load under 1250 foot-candles of light. Response time is four microseconds so that only the mechanical limitations of the card or tape feeding systems limit the speed of operation.

Overhead Crane Wheel Flange Lubrication

A SIMPLE, efficient automatic system for lubricating overhead crane wheel flanges introduced by Acheson Colloids, Ltd., Prince Rock, Plymouth, Devon, uses a stick of solid lubricant held in a spring loaded tubular holder. This stick contains a balanced blend of resin-bonded molybdenum disulphide and colloidal graphite by which the lubricating characteristics of graphite at low and medium loadings are complemented by the excellent extreme pressure performance of molybdenum disulphide.

This form of lubricating device can be quickly and easily fitted and a single stick of the lubricant may last for several months. In service the tip of the stick rubs across the wheel flange whenever the crane moves and quickly imparts a dry, lubricating film that will not attract dust or other abrasives. Lubricating efficiency is unaffected by extremes of temperature, and the small amount of lubricant needed to maintain the film once it has been established is automatically applied and varies according to the severity of the rubbing action between the flange and rail. The holder used is so designed that a stick makes oblique contact with the wheel flange and in selecting the stick size it is important to choose one which avoids any possibility of a film being built up on the wheel tyres.

Launches and Trial Trips

PLANET, light vessel ; built by Philip and Son, Ltd. for the Mersey Docks and Harbour Board ; length overall 133ft, breadth moulded 26ft 6in, depth moulded 12ft 6in ; one 4-ton anchor and 1¼in Tayco cable, air-driven Clarke Chapman windlass ; two compressors, four 16kW diesel-driven alternators, lantern of 685,000 candlepower and 20 miles range. Completed September 6.

HEBE, refrigerated cargo ship ; built by the Ateliers et Chantiers de Bretagne for the Société Navale Caennaise ; length between perpendiculars 358ft 3in, breadth moulded 55ft 10in, depth to upper deck 36ft 1in, draught 24ft, trial speed 19·2 knots ; three 260kW diesel-driven generators ; two S.E.M.T.-Pielstick I.9.L.9PC diesel engines coupled through Vulcan hydraulic reduction gears to one shaft, 6390 h.p. Trial, August.

INDUSTRIAL NEWS

Export Council for Europe

Following the announcement made on October 20 by the Rt. Hon. Reginald Maudling, president of the Board of Trade, that Sir William McFadzean, president of the Federation of British Industries, had agreed to take the lead in bringing about the formation of an export council for Europe, Sir William has now announced its constitution.

The aim of the Council is to support, stimulate and initiate action designed to bring to the notice of British firms opportunities for the expansion of exports to Europe. The first meeting is to be held early in December.

The Council membership includes three representatives from Government departments, Sir Denis Rickett from the Treasury, Sir Patrick Reilly from the Foreign Office, and Mr. G. H. Andrew from the Board of Trade. Representing the sponsoring bodies are Mr. A. Abel Smith, managing director, J. Henry Schroder and Co.; Mr. J. A. Birch, chairman, Trades Union Congress Economic Committee, and general secretary, Union of Shop, Distributive and Allied Workers ; Mr. A. C. Grover, chairman of Lloyd's ; Sir James Hutchison, Bt., president, Association of British Chambers of Commerce, and chairman, Grampian Holdings, Ltd.; Sir Norman Kipping, director-general, Federation of British Industries ; Mr. Morton Oliphant, President, National Union of Manufacturers, and director, Tate and Lyle, Ltd.; and Mr. R. G. Thornton, general manager, Barclays Bank, Ltd. There are also some eighteen individual members representing a cross-section of British industry. Mr. Ion Earle has been appointed the chief executive of the Export Council for Europe, and offices have been taken for the Council at 21, Tothill Street, London, S.W.1.

Overseas Earnings

In its autumn review published in the current issue of the *Bulletin for Industry*, the information division of the Treasury warns that the main danger to the present economic situation is still insufficient overseas earnings. An intensified export drive is called for, the review says, especially since less buoyant world demand makes the export task difficult. The review goes on to point out that the export task would become still more difficult if there were to be a general return in this country to increased costs and prices. There have been signs, the Treasury adds, that the underlying trend in costs is again upward. The rise in income from employment, seasonally adjusted, accelerated in the second quarter, showing a rise of 3 per cent on the first quarter, compared with an average rise of less than 1½ per cent per quarter in the previous four quarters. On the other hand, company profits, which had been rising steeply, levelled off and were unchanged between the first and second quarters of 1960. Prices have been rising a little : in September retail prices were 1½ per cent above a year earlier.

Following the introduction in the first half of 1960 of measures to restrain the growth of credit, the survey notes that the growth has certainly slackened. From the end of May to the end of September this year, hire purchase debt fell by £2,000,000 ; the liquidity of the banks has been lessened and the rate of increase in bank advances has declined; retail sales are high, but the total did not change much in volume between April and September.

Imports are still rising but less rapidly than at the beginning of the year, the article states. Exports, however, have continued to fall, the level in the third quarter being 2½ per cent below that in the second, which was itself 3 per cent lower than that in the first. Investment demand has continued to rise strongly. The net effect of falling export demand, rising investment, and steady personal consumption, the Treasury says, has been that industrial production as a whole did not rise in the third quarter, but it was, however, 6 per cent above that of a year earlier. There has been no decisive easing of the pressure of demand for labour over the country as a whole, the review states ; the effect of the restrictions has been to slow down, considerably, the rate of increase of pressure on labour supplies, but not to bring about a fall.

Iron and Steel

The Iron and Steel Board has announced that the production of steel in October reached a record level of 497,000 tons a week, compared with 441,400 tons a week in October, 1959. The annual rate of production reached 25,842,000 tons compared with 22,953,000 tons in 1959. The production of pig iron during October also set a new record of 313,900 tons a week compared with 269,800 tons a week in October last year. The annual rate of production of pig iron reached 16,321,000 tons, the rate for 1959 being 14,029,000 tons.

Preliminary results of the census of users' stocks of steel taken at the end of September suggest, the Board says, that stocks of finished steel rose by 200,000 tons or about 5 per cent in the third quarter of this year, following rises of 6 and 8 per cent in the first and second quarters. The Board points out that steel sheet has again accounted for the greater part of the rise in stocks, 120,000 tons having been added in the third quarter. During the first three quarters of this year stocks of steel sheet have risen by 263,000 tons or 63 per cent.

Usage of steel in the home market during the third quarter has been estimated at 3,860,000 tons, seasonally corrected. This continues the record rate of usage achieved in the second quarter, the Board says, and represents an increase of 11 per cent over the previous best third quarter, that of 1957.

Sterling Area Exports

The latest statistics published by the Board of Trade reveal a slackening of exports from the sterling area in the first half of 1960. In the first quarter of this year the combined value of sterling countries exports had not maintained the expansion of the previous year. In the second quarter there was a slight fall, and indications for the third quarter for the sterling area are of a seasonal reduction in exports but probably no further underlying fall. A large part of the 13 per cent rise in the value of sterling area exports between the first half of 1959 and the first half of 1960 was due, the Board states, to increased volume.

The 1959 rise in sterling countries' imports continued in the first half of this year, the Board of Trade says, and was particularly marked in the overseas sterling area where the value of imports in the second quarter was some 8 per cent higher than the earlier peak figure in the fourth quarter of 1957. The import picture seems to be again one of rising volume, the Board adds. The rises in import prices both for the United Kingdom and the overseas sterling area have been marginal since the first half of 1959 and the volume of imports into both parts of the sterling area probably rose by about 15 per cent, the Board suggests, between the first half of 1959 and January to June of this year.

Public Health Bill

The Public Health Bill, providing for the replacement of local building byelaws by building regulations made by the Minister of Housing and Local Government and applicable throughout England and Wales outside the county of London, was published last Friday, November 11. The Bill would also amend provisions of the Public Health (Drainage of Trade Premises) Act, 1937, the Ministry says, and incorporate into the general law a number of provisions dealing with various aspects of public health which are already included in local Acts. It does not affect the separate system of building control or separate public health code in force within the county of London.

The main effect of the proposed amendment of the Public Health (Drainage of Trade Premises) Act, 1937, on lines recommended by a sub-committee of the Central Advisory Water Committee which published its report in January this year, would be to enable local authorities to make charges—subject to right of appeal to the Minister—for the reception into the public sewerage system of certain trade effluents whose discharge had commenced before the 1937 Act was passed and which were exempted from control under that Act. The Ministry states that the Bill would classify as trade effluents (and hence within the framework of the 1937 Act should they be discharged into the public sewers) farm effluents and effluents from premises used for scientific research.

Ford Motor Company, Ltd.

The Ford Motor Company, Ltd., of England, announces that it has received a letter from Ford Motor Company of U.S.A. giving details of the American company's intention to make an offer to purchase for cash all of the 17,726,804 ordinary stock units of £1 each of the British company that it does not already own. At present it owns approximately 54·6 per cent of the British company's £39,024,248 issued ordinary share capital. The offer will be, of course, subject to the consent of the Treasury being obtained.

The offer will be conditional, *inter alia*, upon acceptance by the holders of not less than 75 per cent in number and 90 per cent in value of the stock for which the offer is made, or such lesser proportion as may be decided by Ford Motor Company.

PERSONAL AND BUSINESS

Appointments

MR. H. J. BILLING, A.M.I.Mech.E., has been appointed sales director of Metalastik, Ltd.

MR. N. J. WINNETT has been appointed manager of the Swinton Works of The General Electric Company, Ltd.

MR. JACK BLACKBURN, works manager of Bonnington Castings, Ltd., has been appointed to the board of the company.

DR. A. TREVOR CHURCHMAN has been appointed deputy director of the Central Electricity Generating Board's Berkeley Nuclear Laboratories.

F. TAYLOR AND SONS (MANCHESTER), Ltd., announces the appointment of Mr. T. H. B. Lawther as a technical sales executive in the mining plant division.

W. C. HOLMES AND COMPANY, Ltd., announces that Mr. A. J. M. Henshaw has been appointed assistant managing director. Mr. B. J. Duncan has been appointed sales manager.

DR. CHARLES RICHARD WEBB has had the title of Reader in Mechanical Engineering in the University conferred upon him in respect of the post held by him at Queen Mary College, University of London.

THE MINISTRY OF AVIATION has appointed Brigadier J. A. Fitzpatrick to be director of munitions on its defence research staff with the British Defence Staffs in Washington in succession to Brigadier C. T. D. Lindsay.

BRITISH RESIN PRODUCTS, Ltd., has appointed Mr. John S. Murphy as press officer for "Styron" and "Rockite" moulding materials, and "Cellobond" and "Epok" resins.

THE GOODYEAR TYRE AND RUBBER COMPANY, (GREAT BRITAIN), Ltd., has announced the appointment of Mr. A. H. Fuhrig as manager of its technical division in succession to Mr. H. L. Matheson who has now returned to the parent company in Akron, Ohio, U.S.A.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., states that Mr. P. L. Edwards has retired from the managership of the Dublin office of Associated Electrical Industries Export, Ltd., but will continue for a time as consultant. He has been succeeded as manager by Mr. J. W. Jackson.

THE UNITED STEEL COMPANIES, Ltd., has also announced that Lieut.-Commander G. W. Wells, managing director (production) of the company, and director and general manager of the Appleby-Frodingham Steel Company branch, becomes chairman of Appleby-Frodingham Steel Company. Mr. J D. Joy, director and deputy general manager of Appleby-Frodingham, becomes director and general manager of the branch.

SAUNDERS VALVE COMPANY, Ltd., announces that, while remaining joint managing director with Mr. A. L. Trump, Mr. P. T. Stephens has been appointed deputy chairman. Mr. P. C. E. Rose, an executive director, has been appointed general manager of the company's industrial divisions.

CONCRETE, Ltd., announces that Mr. Robert Mack has now moved from the East Midlands to take up the post of senior representative of Concrete (Northern), Ltd., in Manchester. Mr. Walter Dickinson, A.M.I.Struct.E., remains available for consultation as resident director in Manchester.

THE UNITED STEEL COMPANIES, Ltd., states that Mr. A. E. Bell and Mr. R. Lancaster have been appointed to the board of Distington Engineering Company, Ltd. Mr. Bell becomes director and commercial manager, and Mr. Lancaster becomes director and general works manager.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY announces the following senior appointments in its development and engineering group. Mr. R. V. Moore, formerly director of reactor design, and Dr. H. Kronberger, formerly director of research and development, have been appointed deputy managing directors. Mr. P. T. Fletcher will be deputy managing director, general management. Mr. Moore will be deputy managing director, projects; and Dr. Kronberger will be deputy managing director, development. Mr. S. Fawcett, formerly deputy director, has succeeded Mr. Moore as director of reactor design. The research and development directorate at Risley has been divided into two executive directorates: Dr. H. K. Hardy and Mr. F. W. Fenning have been appointed respectively as director of fuel element development and director of reactor technology.

MR. GEOFFREY B. TAYLOR has been appointed a director of The Rhymney Engineering Company, Ltd., in place of Mr. W. Messer, who has retired.

THE SHAND AND JURS COMPANY, of Berkeley, California, and Whessoe, Ltd., of Darlington, have concluded an extension to their mutual agreement giving Whessoe the exclusive right to manufacture S. and J. tank fittings in France and the exclusive right to sell these fittings within the European Economic Community and the French Union.

THE SHIPBUILDING EMPLOYERS' FEDERATION announces that Mr. John Rannie, shipyard director of John Brown and Co. (Clydebank), Ltd., has been elected president for the coming year, in succession to Mr. G. Harold R. Towers, chairman and managing director of John Readhead and Sons, Ltd. Mr. R. Cyril Thompson, chairman of Joseph L. Thompson and Sons, Ltd., becomes senior vice-president; Dr. Denis Rebbeck, deputy managing director of Harland and Wolff, Ltd., and Mr. Henry Robb, chairman and managing director of Henry Robb, Ltd., have also been appointed vice-presidents. Mr. George Hilton, managing director of Scotts' Shipbuilding and Engineering Company, Ltd., has been elected chairman of the Conference and Works Board, and Mr. Thomas McIver, a director and general manager of Swan, Hunter and Wigham Richardson, Ltd., has been elected vice-chairman.

Business Announcements

CATERPILLAR TRACTOR COMPANY, Peoria, Illinois, U.S.A., has announced the formation in France of a subsidiary company, Caterpillar France S.A.

ELLIOTT-AUTOMATION, Ltd., states that its Swiss subsidiary, Elliott-Automation A.G., has moved into new and larger offices in Zurich at 32, Holbeinstrasse, (telephone, 47 05 70).

LAPORTE INDUSTRIES, Ltd., announces that it has purchased from Head Wrightson and Co., Ltd., the whole of the issued capital of the Cupola Mining and Milling Company, Ltd.

MR. R. CRESSOR-WATTS has established a consulting and designing civil engineering practice at the following address; c/o Lewis and Hickey, 7, Hanover Street, London, W.1 (telephone, Mayfair 0753).

MR. H. C. MARGRETT, general manager and a director of G.E.C. Overseas Services, Ltd., a subsidiary of The General Electric Company, Ltd., has retired after forty years' service with G.E.C.

SAMUEL OSBORN AND CO., Ltd., Sheffield, has opened a new warehouse at 7, Millfields Road, Bilston, where stocks of tool steels, engineers' small tools and files will be maintained for the convenience of customers in the Birmingham and Midlands area.

VICKERS-ARMSTRONGS (ENGINEERS), Ltd., states that because of the increase in the volume of business for its "Worssam" products, it has formed a Worssam products division. Mr. E. W. French has been appointed manager of the new division, and Mr. L. F. Worssam, sales manager. The new division will be based at the Crayford works of Vickers-Armstrongs (Engineers), Ltd., and the sales office will be retained at Vickers House, Broadway, London, S.W.1.

BAKER-PERKINS, Ltd., Westwood Works, Peterborough, has acquired Alfred Porter and Co., Ltd., and its three affiliated companies, of Stella Works, Stanley Road, Teddington, Middlesex. The operations of Alfred Porter and Co., Ltd., will be integrated with William Douglas, Ltd., a member of the Baker Perkins Group. Mr. T. E. M. Douglas, managing director of the Douglas company, will be in charge of the joint operation and Mr. G. F. A. Crook, managing director of Alfred Porter and Co., Ltd., will join the Douglas board.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., Imperial Chemical House, Millbank, London, S.W.1, has completed the purchase of some 200 acres of land at Kilroot, near Carrickfergus, County Antrim, as a site for a factory for the manufacture of "Terylene" and possibly other man-made fibres. Site development at Kilroot will begin early in 1961 with a view to starting production in 1963. When full production has been achieved, a labour force of about 1150 will be required and, if the project succeeds in accordance with expectations, it is hoped to expand the plant to give eventual employment to at least 2000. During the construction period it is expected that the company's contractors will require a labour force rising to some 600 to 800 men in 1962-63.

DESOUTTER BROTHERS (HOLDINGS), Ltd., has announced the formation of a new subsidiary—Carter Stevens (Automation), Ltd.—to carry on the business of Carter Stevens and Company (Engineering), Carter Stevens and Company (Automation) and Blakeman Designs, all of Coventry. Messrs. W. J. Carter, P. Stevens, G. D. Simpson, R. E. Stockley and D. W. Blakeman are joining the board of the new company.

THOMAS INDUSTRIAL AUTOMATION, Ltd., has opened new sales and service centres in London, Birmingham and Bristol. They are as follows: London, Mr. V. J. Alan and Mr. J. C. East, 59, Victoria Street, Westminster, S.W.1. (telephone, Abbey 1816). Birmingham, Mr. D. R. Jones, A. M. Lock and Co., Ltd., Newborough House, Newborough Road, Shirley, Solihull, Warwickshire (telephone, Shirley 5703). Bristol, Mr. J. St. Alphonse, Western Industrial Equipment, Ltd., 54, Queen Square, Bristol, 1 (telephone, Bristol 26630). The company has also announced the appointment of Mr. A. Quinn to take charge of the service division at head office, Altrincham.

Contracts

SIMON HANDLING ENGINEERS, Ltd., announces that it has been awarded a contract for the supply of four travelling pneumatic ship-discharging plants by the Port of Bristol Authority. Each plant will have a capacity of 200 tons an hour and will be complete with quay conveyor installation. The value of the contract exceeds £500,000.

MITCHELL ENGINEERING GROUP, Ltd., has been awarded a contract valued at approximately £440,000 for the construction of a coal preparation plant at Blidworth Colliery, Notts, by the East Midland Division of the National Coal Board. The plant will be designed to clean run-of-mine coal from the "Top Hard" and "Hazel" seams at Blidworth at a maximum rate of 400 tons per hour.

THE TRANSFORMER DIVISION OF ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., is to build two 340MVA generator transformers, worth about £400,000, for the Central Electricity Generating Board; they are the largest generator transformers so far scheduled by the Board. Installed at West Thurrock power station, they will be connected to two A.E.I. 300MW turbine-generator units for supply to the 275kV Supergrid. They will have a no-load voltage ratio of 18.5kV/300kV, delta/star connected. Tappings, catering for voltage variations of ± 10 per cent in eighteen equal steps, will be provided at the neutral end of the h.v. windings, and will be connected to A.E.I. high-speed resistor-transition on-load tap changers arranged for local electrical and remote electrical control. The transformers will be cooled by circulating the oil through oil/water heat exchangers. The core and windings of each transformer will be contained in an aluminium tank to reduce stray losses and weight. For strength and abrasive resistance when winching the transformers into position on site, the base and the lower part of the tank will be made of steel, a gasketed joint being used between the two parts. Each complete transformer will have overall dimensions of 47ft length, 22ft width and 28ft 6in height, and will weigh 280 tons (transport weight about 185 tons).

Miscellanea

THE October, 1960, *Monthly Statistical Review* of the Society of Motor Manufacturers and Traders, Ltd., contains the figures for the first six months of 1960 of United Kingdom exports and of the exports of the main producing countries to all destinations. The United Kingdom was the second largest exporter of both cars and commercial vehicles, the numbers being: cars, W. Germany 446,042, United Kingdom 364,298; commercial vehicles, U.S.A. 108,432, United Kingdom 74,207. Of the United Kingdom exports, 51·5 per cent of the cars and 55 per cent of the commercial vehicles went to destinations in the British Commonwealth and Empire or Eire; by value these proportions are smaller, apparently because, compared to average prices of £388 for cars and £705 for commercial vehicles, Australia averages only £248 for cars and £590 for commercial vehicles, while New Zealand averages £480 for commercial vehicles. Outside the Commonwealth, there are three significant markets to which the United Kingdom is the largest exporter, namely the Irish and Argentine Republics and the Sudan.

CONTINENTAL AFFAIRS

by Our Continental Editor

French Nuclear Developments

THE Report of the Commissariat à l'Energie Atomique (C.E.A.) for 1959 has now been published.* As well as being concerned with the development of nuclear energy, the Commissariat is charged with attending to other aspects, such as military applications and submarine propulsion. While as recently as two years ago it had been estimated that in France nuclear electricity would reach the break-even point with other sources of power by 1965, this date has now been put back by a further four to five years, in view of the resources of natural gas now becoming available from the Sahara.

The year covered by the report was the fourteenth since the setting up of C.E.A. immediately after the war. Between 1946 and 1952 the principal effort was devoted to the construction of major tools of research—two heavy water reactors (EL1 and EL2), one Van de Graaff accelerator of 5MV, one 25 MeV cyclotron—as well as the setting up of the Saclay research centre, the discovery and opening-up of French deposits of uranium, and the development of the production of the principal nuclear materials.

The second period, from 1952 onwards, was characterised by the construction at Marcoule of three graphite reactors G1, G2 and G3 for the production of plutonium, and the setting-up of an extraction plant. In the case of G2 and G3, the energy liberated was also utilised for producing electricity, so that these reactors became the first sources in France of nuclear power.

While in the case of Marcoule electricity has been a by-product, the C.E.A. is continuing its co-operation with E.D.F. in connection with the nuclear power plants E.D.F. 1 and E.D.F. 2 at Chinon which by 1965 are to have an installed electric capacity of 750MW.

Last year saw the attainment of criticality by G3 and of full production by G2 as well as the plutonium factory. In addition, the power of the reactor " Melusine " at the Grenoble Centre was stepped up, the large accelerator " Saturne " came into full service, and the pilot plant at Toulouse began the production of heavy water by fractionated distillation of liquid hydrogen.

These seven years of the first French atomic programme, which also included preparations for the first French nuclear explosion, saw a sixfold increase in personnel and a rise in the budget which reached 2 per cent of the total national budget.

Such an expansion necessitated a thorough overhaul of the existing organisation. This resulted last year in the regroupment of technical departments into two divisions, the Physics and Reactor Section, and the Nuclear Materials and Fuel Section, while a combined section was created and set up for Industrial and Administrative matters, as well as Planning and Public Relations ; a separate Finance and Account Section was put in charge of that side of the organisation.

It is anticipated that growth will continue during the next four years, though at a lesser rate. From 1960 onwards several new lines of research will be broached—about half as many as in the U.S.A.—including natural uranium and heavy water reactors, breeder reactors, reactors employing enriched uranium, in particular those for the propulsion of merchant ships and naval vessels such as submarines.

The report foresees the production of operational nuclear weapons and of military power units, and in this connection the beginning of U235 production. Pilot and corresponding full-scale factories which have been studied during the last few years will be set up from 1960 onwards so as to reach completion in 1964–66. This effort will be in addition to the follow-up of the achievements of previous plans.

Personnel.—Between January 1 and December 31, 1959, the total number of employees of C.E.A. increased from 10,715 to 12,218 (excluding work forces recruited overseas). This constitutes an increase of 14 per cent as compared with 18 per cent in 1958, 40 per cent in 1957, and 28 per cent in 1956.

The numbers at the beginning and end of the year under review were made up as follows :

	Staff	Others
Headquarters	370 (441)	744 (928)
Scientific establishments ...	1311 (1527)	3795 (4660)
Industrial establishments ...	111 (128)	1562 (1947)
Mining research and exploitation	176 (177)	2646 (2410)
Total	1968 (2273)	8747 (9945)

If temporary overseas work forces and those seconded from the universities are added to the end-of-year figure, a total of nearly 14,000 persons is arrived at, as against 12,000 a year earlier.

Research Centres.—The C.E.A. maintains three research centres, at Fontenay-aux-Roses (Cenfar), at Saclay (C.E.N.S.), and at Grenoble (C.E.N.G.), as well as the Centres for Military Applications. Construction of a fourth centre at Cadarache at the confluence of the rivers Durance and Verdon, was decided upon during the year.

Cenfar.—Modernisation of this original centre of the C.E.A. was decided upon in 1955. This involved considerable planning so as to avoid excessive interruption of current work. The rebuilding involved levelling the area of 13 hectares of this former fort, a fact which additionally complicated the enterprise.

The first C.E.A. reactor, " Zoé " (EL1) is always in operation. Until July, 1959, it was used for producing radioactive isotopes and, at night, for the testing of materials. A large proportion of its personnel was transferred to the 1200kW swimming pool reactor " Triton " which attained criticality on June 29, and the swimming pool reactor " Minerve " which became critical in September. " Triton " is intended for safety studies, and " Minerve " for precision measurements of the capture cross section of fuels already irradiated in high-flux reactors.

Other aspects of work at this centre are plasma and thermonuclear research, chemistry and metallurgy of plutonium, mineral treatment, and the use of molten metals as coolants.

C.E.N.S.—The Centre d'Etudes Nucléaires de Saclay is the major research institution of the Commissariat. Equipment includes the reactors " EL2," "EL3," and " Proserpine," the proton-synchrotron " Saturne," a Van de Graaff accelerator, a cyclotron, and a linear accelerator, as well as numerous laboratories.

The principal events of last year, besides the intensive operation of " Saturne," were the opening on April 16 of the Laboratory for the Examination of Irradiated Fuel (L.E.C.I.), the attainment of criticality of the reactor " Alizé " on June 18, and in September, the installation in a new building of the National Institute of Nuclear Science and Technology (I.N.S.T.N.).

The L.E.C.I. laboratory is equipped for the study of fuels after irradiation. It has eleven hot cells with telemanipulators and heavy shielding. It was intended to achieve full operation in October of this year.

Installation of irradiation equipment in EL3 has been completed by the maker, Société Hispano-Suiza. The reactor " Alizé," completed in ten months, is intended for criticality studies of cores of enriched uranium moderated with ordinary water. Its power is limited to a few watts.

In April, the synchroton " Saturne " for the first time was stepped up from 600 to 1100 pulses per hour. It has been operated in two daily shifts on five days per week, with one maintenance shift on Saturdays; the designers required two days per week for studies and improvements to the beam. Three-shift operation is to be adopted later. Various experiments involving mesons of over 900 MeV have been carried out with this equipment.

Although it is not intended to increase further the number of people working at Saclay, it appears necessary to provide new buildings or modify others to house ancillary equipment. A new facility which came into operation is an assembly shop for experimental erection of cores before their installation. Laboratories have also been constructed for the " Saturne " synchrotron, the High Activity Laboratory has been enlarged, and a new laboratory for the manufacture of artificial radioactive elements is to be erected.

C.E.N.G.—Construction of laboratories and workshops at Grenoble has continued with the object of providing facilities for 1000 people by December, 1960. Since its commissioning in April the reactor " Melusine " has been operating, at first at 1200kW and more recently at 2000kW. The reactor serves for low temperature irradiation experiments, chiefly in connection with the physics of the solid state, neutron diffraction, and radio chemistry. A " hot cell " has now been added which communicates with the " swimming pool " through a lock. A loop for irradiating samples at the temperature of liquid nitrogen (80 deg. K) has been added, also a neutron diffractometer. The electrostatic accelerators have been rehoused in a new building specially equipped with appropriate shielding and laboratory facilities. A 150kV machine supplied by the Société Anonyme du Machines Electrostatiques is being used as a pulsed neutron generator.

C.E.N.-C.A.—The Centre d'Etudes Nucléaires du Cadarache was set up on November 1, following the decree of October 14 authorising the Commissariat to proceed with the necessary expropriations. The Centre will occupy a mainly wooded site of some 1600 hectares at the confluence of the Durance and Verdon. The following reactors are to be constructed there : " Pégase," an experimental reactor for testing fuel elements for gas-cooled power reactors ; " Rapsodie," a sodium-cooled fast neutron reactor ; and the land-based prototype of a submarine propulsion unit. These reactors will be associated with the necessary laboratories, workshops and other buildings. Personnel is due to increase from twenty at the end of 1959 to 150 a year later, and finally to 450—500 at the end of 1962.

Military Centres.—Considerable expansion has taken place during the year under review in connection with the infrastructure of the various centres of the Directions des Applications Militaires (D.A.M.), in accordance with Government plans, from 1955 onwards, to enable an experimental nuclear explosion to be carried out at the beginning of 1960. This work is being financed for the most part by the War Ministry. Installations include principally : a mathematical centre, equipped with modern calculating machinery ; high activity laboratories type

* " Rapport Annuel, 1959." Commissariat à l'Energie Atomique, 69, Rue de Varenne, Paris (7e).

CONTINENTAL AFFAIRS *(Continued)*

" Alpha " in which up to several kilogrammes of plutonium can be treated in one operation ; and special facilities for ballistics research. The D.A.M. took over the Atomic Section of the Directorate for the Study and Manufacture of Armaments ; finally, it proceeded to construct at Reggane, laboratories and the tower for the test explosion.(*)

Production of Basic Materials

The centres of production of C.E.A. are, on the one hand, the Mining Divisions and their associated factories, and on the other, the uranium factories at Le Bouchet and Malvesi, and the plutonium centre at Marcoule.

Of nuclear materials, the Commissariat itself produces natural uranium, thorium, uranium 233, and plutonium. Enriched uranium is at present imported from the U.S.A.; a decision has been taken to set up in France a plant for the separation of the U235 isotope. Other materials such as graphite, zirconium, beryllium, &c., are either furnished by industry or manufactured jointly.

In 1959, the production of uranium concentrates amounted to 820 tonnes, of which 300 tonnes were produced by private mining companies in France and Madagascar. The total quantity was 30 tonnes more than planned. Because of the current danger of short-term overproduction and the uncertainty with regard to the long-term demand, French fuel production plans have been trimmed in conformity with the spaced-out programme covering the period until 1970. Systematic prospecting continues, however, in order to safeguard against a possible future shortage of raw material.

Up to the end of 1959 ground prospecting had been carried out over 80,000 square kilometres in metropolitan France, and 105,000 square kilometres overseas, while aerial prospecting had been carried out over some 580,000 square kilometres of overseas territory, approximately 350,000 square kilometres being covered by this means in the review year above.

Manufacture of concentrates is carried out at Bessines where capacity is being expanded to 600,000 tonnes of ore per annum, Escarpière, Bois-Noirs (initially 180,000 tonnes of uranyl nitrate per annum), and Gueugnon.

Production of pure metal is the task of the Le Bouchet plant. A special design of furnace has been developed for converting the raw material into uranium tetrafluoride which is then reduced with magnesium to yield the metal. A pilot installation is to come into service this year when the construction of a first industrial plant will also be commenced.

The Malvési plant near Narbonne is nearing completion. After trial operation during the period April–September, 1959, 20 tonnes of uranium metal were produced in October, 30 tonnes in November, and 40 tonnes in December. Acceptance tests had been scheduled for the first quarter of this year.

Fritted uranium oxide is being produced commercially by the Compagnie Industrielle des Combustibles Atomiques Frittés (C.I.C.A.F.) at its Corbeville works. A process for the direct production of high density frits (density 10·4 to 10·6) is being developed in collaboration with this firm.

After the decree of September 17, 1958, had declared the project to be of public utility and urgency, C.E.A. commenced the setting-up of an isotope separation plant at Pierrelatte (Drôme).

The principal source of thorium is uranothorianite from Madagascar which is found in the form of monazite, ilmenite and zircon. From these materials the Le Bouchet plant produces thorium nitrate with a metal content of 200 tonnes per month. Besides various improvements to this process, an entirely new method is being developed, and a pilot plant is due to come into service this year.

While the extraction of U233 from irradiated thorium continues to be studied at Saclay, the use of this material in reactors is considered to be so distant as not to warrant at present its manufacture on industrial lines.

Plutonium was first obtained at the Marcoule purification plant in February, 1959, and various improvements were carried out before October when the first charges from the reactor " G2 " were processed. The residue recovery plant at Marcoule went into regular service in September.

Hafnium-free zirconium is being manufactured at the rate of 10 tonnes of oxide, per month at the plant of Nobel-Bozel at Lamothe. This material is converted into sponge metal at the Clavaux factory of Société d'Electrochimie d'Ugine ; output capacity there is 5 tonnes per month. The metal is converted into tubes of over 100mm diameter and 3mm wall thickness by the Comptoir d'Etirage et du Profilage des Métaux, while Tréfileries et Laminoirs du Havre produce zirconium in sheet form. Production of beryllium and of beryllium oxide has been cut back because plans for a high temperature reactor have been cancelled. Experimental tubes for use with the reactor " EL4 " (principally for canning purposes) are being made by Péchiney.

Research

While most research is of an applied nature, a substantial proportion of the effort is devoted to fundamentals. Collaboration is close with the universities, the Centre National de la Recherche Scientifique, and the Polytechnic Colleges. Research contracts let by C.E.A. totalled 256 (196), involving a sum of 32·3 million NF (20,000,000 NF). In France 207 (186) patents were taken out, and 1220 (943) abroad, bringing the total (allowing for the deduction of lapsed patents) to 541 French and 2798 foreign patents applications of which 673 have been granted so far. Like most industrial firms connected with nuclear technology, the C.E.A. is associated with the patent holding company Brevatome. It also collaborates with Euratom in connection with the problem of the automation of documentation.

High Energy Particles.—With the help of " Saturne," studies have been made of the interaction of positive and negative π-mesons at energy levels ranging between 0·38 and 1·7 GeV (1 GeV = 1×10^9 eV). A paper on the second resonance of this interaction was favourably received at the High Energy International Conference at Kiev in July, 1959. The spectrum was investigated of positive and negative π-mesons produced by bombarding copper and carbon by 2·7 GeV-protons. Also investigated was the production of neutral π-mesons from the interaction of charged π-mesons with carbon, and the production of positive K-mesons by interactions of protons with nucleons. Preliminary work has been carried out to study the polarisation by diffusion of a beam of protons falling on a carbon or beryllium target. With 20cm diameter, 3 litre capacity liquid hydrogen bubble chamber the interactions of negative π-mesons with protons have been studied for energies of 500 to 700 MeV. Over 80,000 stereoscopic photographs are now in course of examination, and the first results have been published concerning the angular distribution of π-mesons elastically diffused by protons.

Medium and Low Energy Nuclear Reactors.—With the help of the cyclotron, studies were made in particular of the elastic and inelastic scattering of protons and alpha particles by the zinc isotopes 64, 66 and 68, the accuracy of the magnetic analysis of the scattered particles being raised to a few parts per thousand of the energy. Other topics of experimental study included work on sources of polarised protons, an electron monochrometor, the nuclear absorption of photons in aluminium and carbon, and the production of monochromatic photons by the annihilation of relativistic positrons.

In the low energy field, full use was made of the 5,000,000V Van de Graaff machine to study the nuclear cohesive forces in ruthenium, angular distributions in proton-neutron reactions, and the inelastic scatter of 3 MeV neutrons in bismuth and iron. The linear electron accelerator, and the time-of-flight neutron spectrometer installed at the reactor " EL 3," have made possible the precision measurement of neutron capture and total effective cross sections.

Isotope separations have been carried out for other services of C.E.A. or outside laboratories.

Other Studies.—With the object of providing polarised nuclear targets, and in order to obtain a better understanding of the interaction of electron and nuclear spins, work was continued on obtaining an important degree of dynamic polarisation (of the order of 10 per cent).

Research into controlled fission, after a period of over-optimism as regards the possibility of early practical results, is now proceeding in a more fundamental direction. Practical work is along three main lines : the use of toroidal plasma configurations in the machines " TA 2000 " and " Equator"; the injection of plasma into magnetic mirror configurations ; and the formation of a plasma by injecting into a rotating magnetic field, molecular ions accelerated from an annular source, the ions having been dissociated by, for instance, a discharge set up in deuterium.

Finance

In the year 1959, the C.E.A. expended 1020 million NF, of which 288 million was spent on research, 276 million on production, 321 million on raw materials and other stocks, and 135 million on overheads of all kinds. This compares with a total expenditure of 685 million NF in 1958, and 461 million NF in 1957.

(*) The explosion took place on February 13.

British Ford Convention in Hamburg

Last week more than 1000 representatives from fifteen European countries assembled at Hamburg for an international convention, product demonstration and display staged by Ford Motor Company, Ltd., with the overall theme of "Ford of Dagenham Comes to Europe."

The Convention began on November 8, and its early stages were devoted largely to matters affecting Fordson tractor marketing policy. It ended on November 11, and the programme included a spectacular display of the entire range of British Ford products—cars, trucks and tractors.

Dagenham's current progress is most marked by the gains being made with its light cars, tractors and heavy commercial vehicles. A comparison of the first eight months of the current year, with the same period of 1959 shows that in the class comparable to the " Anglia " (the biggest-selling category in Europe) the Ford share of the market has increased from 3·9 to 12·4 per cent in Belgium, from 2·4 to 5·9 per cent in Switzerland, from 6·6 to 20·2 per cent in Norway, and from 8 to 13·1 per cent in the Netherlands, and from 3·9 to 10·6 per cent in Portugal. Some 36,000 " Anglia's " were sold to Europe during this period, and total sales of Dagenham-made light cars to Europe are expected to be up by 57 per cent this year compared with 1959.

In the heavy commercial field during 1959 sales to Europe amounted to nearly 3000 trucks ; by the end of 1960 they will have risen to over 4000.

European sales of British Fordsons amounted to 18,800 " Majors " and " Dextas " in 1959. By the end of this year this figure will probably reach 19,400. A great contribution to this growth is stated to have come from the " Dexta," which was largely designed with Europe in mind. The company's share of British car exports to Europe amounts to 60 per cent of the total, and its share of tractor exports is 40 per cent.

THE AMERICAN SCENE

by Our American Editor

Machine Tool Exposition and Production Engineering Show at Chicago

No. III (*Continued from page* 820, *November* 11)

The 1960 *Machine Tool Exposition and the Production Engineering Show were held, respectively, at the International Amphitheatre and the Navy Pier in Chicago from September* 6 *to* 16 *and were attended by over* 150,000 *visitors. Compared to the previous exhibitions held in* 1955, *there has been a major increase in the application of numerical control to both standard and special-purpose machine tools. This article reviews the more important advances in the design, construction and performance of the machinery shown and deals particularly with the present state of automatic machine tool control in the United States.*

JONES AND LAMSON MACHINE COMPANY

THE display of the " Model 30-60 deg. Auto-Tracer " lathe at the stand of the Jones and Lamson Machine Company, Springfield, Vermont, was an outstanding example of advanced tracer control. This single-spindle automatic lathe (Fig. 14) is a compact, rugged machine, abundantly powered to take full advantage of the latest developments in carbide cutting tools. There can be as many as four different tracing cuts in a single machining cycle, with up to four different speed changes and four different feed changes occurring automatically during each of the cuts.

Automatic spindle speed changes in the headstock are made hydraulically by multiple-disc clutches through constant mesh gears, and spindle stop is also by a hydraulic multiple-disc brake. The two-speed headstock permits automatic speed change during cut between two spindle speeds, in one only of the following ratios : 1 : 1·5, 1 : 2, or 1 : 2·5. Change gears make 16 spindle speeds available ranging from 115 to 3162 r.p.m. with a 6in spindle, and 73 to 1830 r.p.m. with an 8in spindle. The alternate four-speed headstock permits automatic speed change during cut between four spindle speeds. The ratio between the low and the three higher speeds is 1 : 1·5, 1 : 2·5, and 1 : 3·5. Change gears make 32 spindle speeds available, ranging from 137 to 3013 r.p.m. with a 6in spindle, and 87 to 1910 r.p.m. with an 8in spindle.

The tracer carriage, with chromium-plated bearings, rides on the hardened and ground steel rails of the upper bed. The tracing slide is positioned at a 60 deg. angle with and above the spindle axis. An eddy-current motor and lead screw drive provide infinite longitudinal feed selection, from 1·5in to 40in per minute. The motion of the tool-carrying member of the tracing slide is by hydraulic servo control, guided by a stylus and template. A single template provides guidance for all four tracing cuts, thus eliminating multiple templates. This tracing unit may be cycled for either 1, 2, 3, or 4 automatically controlled cuts.

A typical fully automatic cycle, when using a four-cut set-up, would be as follows. The tracer will follow through up to three roughing cuts using as many as four feeds and four speeds occurring automatically during each of the cuts. Each feed and each speed can be used twice in each cut. The tool holder then automatically indexes to the finishing tool. The finishing cut is now completed, also with as many as four speeds and four feeds occurring automatically during the cut. Rapid travel, approach and return is provided with each pass. The depth of cut for each pass is automatically controlled by an indexing spool. Four adjustable pins change the relative distance between stylus and tool point, and the maximum radial stock removal is 1¼in.

The operator control station programmes the sequence of all machine functions within a fully automatic cycle. It carries all push-button or selector controls and is mounted on the front side of the headstock within easy reach of the operator. A drum on the control station rotates in relation to the tracer carriage feed screw. This drum carries graduated dog rings which are adjustable. As the drum rotates, the dogs trip appropriate micro-switches within the control station to obtain various machine functions in their proper sequence. Individual potentiometers on the front side of the machine establish each desired feed for both tracer and auxiliary slides. Above each potentiometer, indicating lights show which feed is in operation. Meters on the top side, one for the tracing slide and one for each rear slide, indicate feed rate in inches per minute. A chart between meters converts feed to thousandths per revolution. The feed for the facing and necking slides is controlled by a hydraulic flow meter.

All programming is accomplished within the operator zone. Since all machine functions and tool cutting edges are visible from this zone, accurate settings for their control are made extremely easy. Once a job has been set up, it is recorded on a job set-up card. A knife edge,

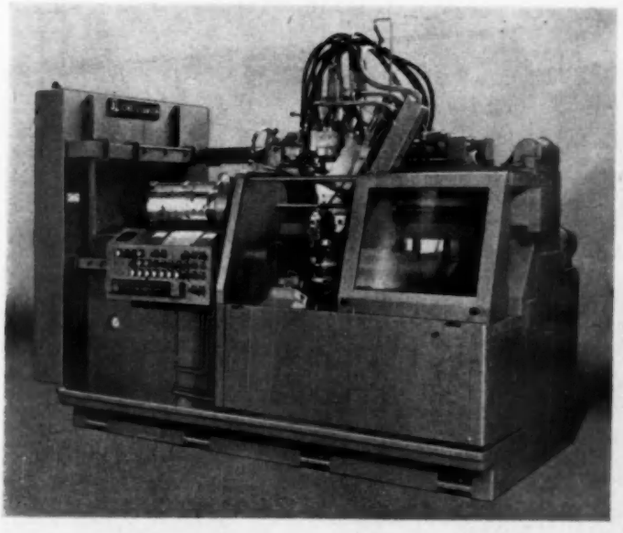


Fig. 14 (Above)—Jones and Lamson " Model 30-60 deg. Auto-Tracer " lathe with automatic cycle drum control

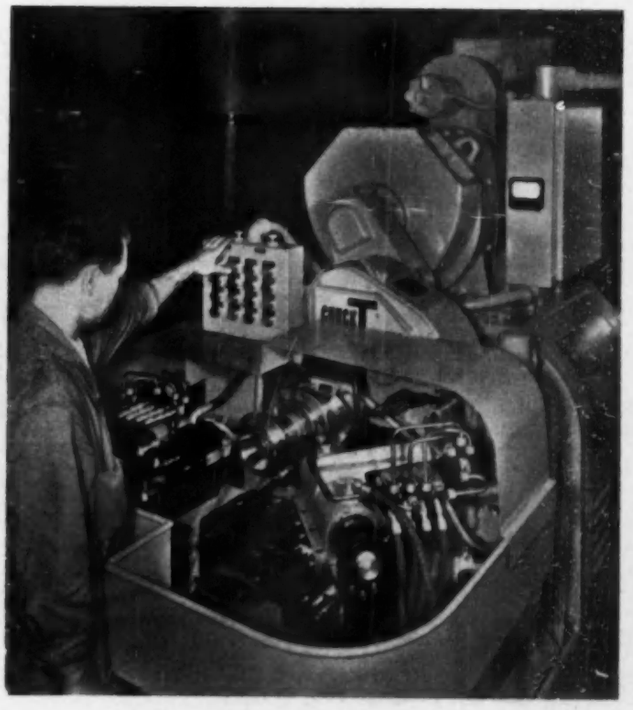


Fig. 15 (Right)—National Acme " Chuck-T-Matic " 12in single-spindle chucking machine with hydraulic tracer control

THE AMERICAN SCENE *(Continued)*

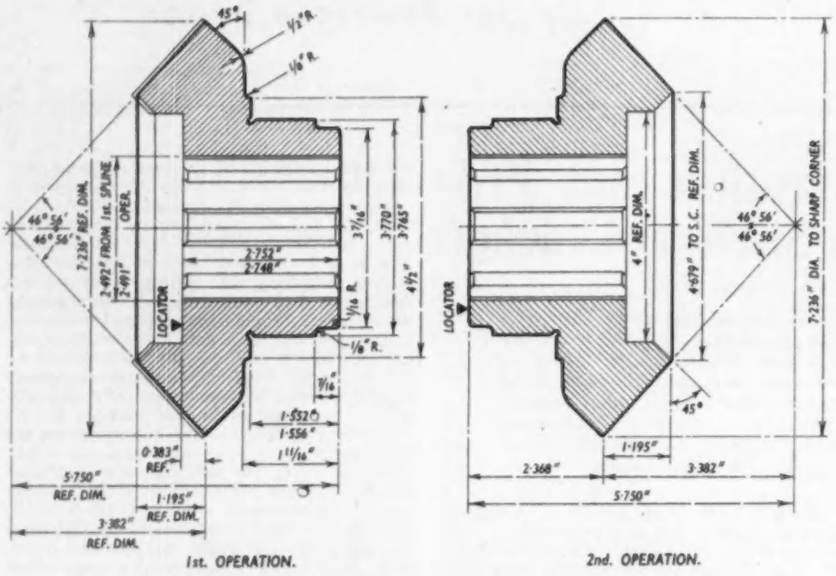


Fig. 16—Bevel gear blanks machined at the show on the chucking machine

numbering all of the dog rings, is flipped down to meet the control drum. It is then a simple matter to read off the graduated settings for each individual dog ring and to record them.

The National Acme Company

In addition to its well-known multiple-spindle automatics, the National Acme Company, of Cleveland, Ohio, displayed its new "Chuck-T-Matic" 12in single-spindle chucking machine (Fig. 15). Developed particularly to obtain maximum versatility within its capacity, this all-hydraulic, tracer-equipped lathe is ideal for second operation work. One or more of these machines can be used to supplement existing equipment and prevent production bottlenecks. The "Chuck-T-Matic" is a single-spindle chucking machine designed to accommodate hydraulic tracing units on either or both slides. Its high speed mechanism can be either pneumatically or hydraulically operated. The variable speed d.c. motor drive and automatic controls vary the spindle speed to provide constant surface cutting speed to the tracer tools. This arrangement provides uniform finish on various diameters and is a great aid to prolonged tool life. The dual tracer attachments minimise handling time and let the lathe perform two operations in any selected sequence. There are no cams or gears to change, and the tracer templates position the preset tools which automatically actuate the controls to obtain proper spindle speed for any diameter from $\frac{7}{8}$in to $9\frac{1}{2}$in.

At Chicago, the machine was demonstrated finishing S.A.E. 4150 steel bevel gear blanks as shown in Fig. 16. The "Chuck-T-Matic" is able to produce finished gear blanks in 113 seconds in two separate operations on one set-up. These blanks are splined and have 0·090in to 0·100in on the diameter for finish cutting. Utilising variable spindle speed at constant feed, the total machining time for the two operations is indicated. On an ordinary lathe approximately 24 minutes would be required. The new machine saves over 90 per cent in time as well as improving both the quality and accuracy standards.

The Fosdick Machine Tool Company

The most interesting machine in operation at the booth of the Fosdick Machine Tool Company, Cincinnati, Ohio, was the new "Fosmatic 54-P" precision boring machine (Fig. 17), equipped with tape control of saddle, table, spindle speeds and feeds, spindle depth, head, and automatic tool changing. The automatic tool changing unit on this machine holds up to 100 boring, drilling and end-milling tools. It is controlled from the same tape control console which positions and controls the machine.

The heart of the numerically controlled machine is its "Direct Dimension Measuring System." This system sets up co-ordinate dimensions mechanically by aligning selected Class A gauges. When used with numerical control, the dials of the measuring system are automatically set by an electro-mechanical system controlled from the tape. The eight-channel tape employed also controls spindle feeds, speeds, spindle depth, head height and automatic tool changers. The machine thus becomes completely automatic, and the production of holes with extreme accuracy of location, size and depth thus becomes a reality with no special effort on the operator's part.

The use of numerical control also eliminates much costly tooling. Proper feeds, speeds, and depths are punched on to a tape, decreasing non-cutting intervals and avoiding split-second decisions on the part of the machine operator. Better tool life and perfectly machined parts are the result. Many times an entire job can be programmed with as few as five or six different tools even though it may have thirty or forty different operations involving several different depths of cut for each tool. Among the features of these numerically controlled machines are indicators which show the machine operation number and tool number, visual read-out of all dimensions, retention of the handwheels for manual control, and controls that permit the operator to assume control of any function of the machine at any time. Lights are also provided to signal any malfunction in the reader and storage circuits. Since the system is predominantly electro-mechanical, maintenance can be handled by any able electrician.

The American Tool Works Company

A new numerically controlled travelling 19in column openside boring and drilling machine (Fig. 18) was exhibited by the American Tool Works Company, of Cincinnati, Ohio. Specifically designed to cut machining costs in "extra large" work applications, this boring and drilling machine can also be set up for a number of "smaller" jobs—permitting set-up in one or more areas while machining in another area. The pre-selective hydraulic head employs silent, effortless shifting, with advance selection of speeds, feeds and tap leads. The precise positioning of holes is established very simply by a General Electric control system, without requiring jigs or layout. The machine positions by tape control to close tolerances on both the "X" (saddle) and the "Y" (head) axes. The saddle and head travel on hardened and ground replaceable ways, and work can be machined anywhere within the 15ft by 6ft working area.

A machine of this type recently found an interesting application at the Food Machinery

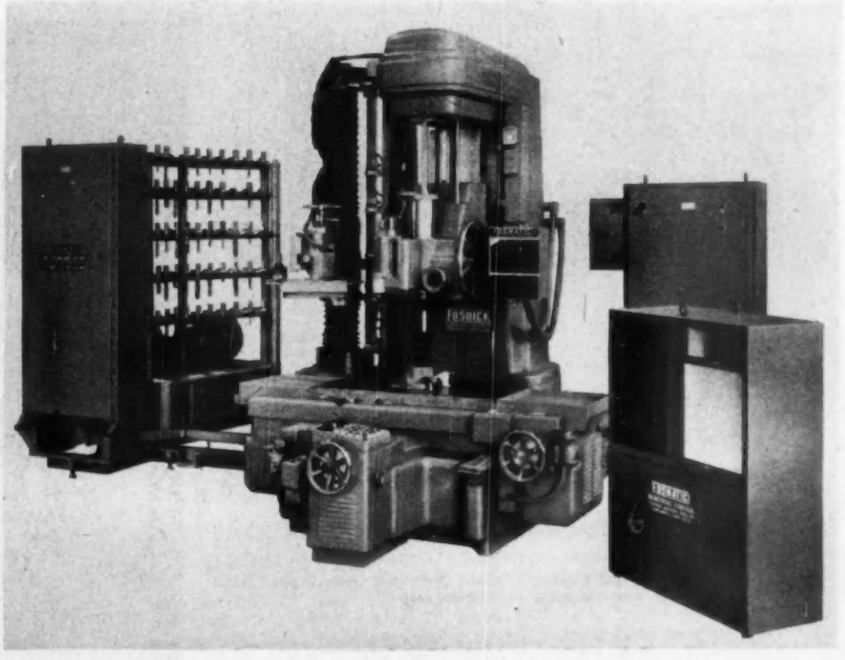


Fig. 17—Fosdick "Fosmatic 54-P" precision boring machine with tape control and automatic tool changing unit

Fig. 18—American Tool Works travelling 19in column openside boring and drilling machine with General Electric numerical control

and Chemical Corporation, Hoppeston, Illinois. Before it went into service, the placement of machined holes left much to be desired, even though they were produced by drill jigs and piloted boring bars, horizontal boring mills, vertical mills and jig borers. As a result, each hole merely became a compromise between accuracy and cost. The tape-controlled unit now satisfies two main needs. Firstly, it places the holes accurately and quickly. And, secondly, it provides both of these functions with a minimum of tool cost. It is a machine that places holes with almost the accuracy of a jig borer, with the speed of a radial drill and the rigidity of a milling machine.

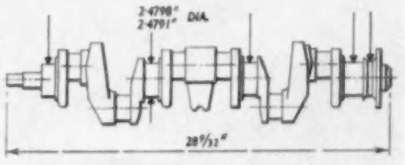
In the control unit the needed data for one position are read at one time and the machine responds instantaneously. This block reading reduces the size of the control equipment and the number of components, since there are no information storage circuits. The block reader also gives the operator the opportunity to withdraw and return the table from under the spindle to check a hole size.

The Norton Company

A fine example of a modern transfer line (Fig. 19) was installed at the stand of the Norton Company, Worcester, Massachusetts. This three-station line is employed for grinding and lapping all bearing surfaces on a six-throw automobile crankshaft, as shown in the accompaying operation sheets (Fig. 20). On exhibit and operating also were the overhead rail double hook loaders and conveyor equipment. The first machine in the transfer line was the firm's new 10in by 30in "Type CM-2" semi-automatic multi-wheel grinding machine. This unit was tooled to grind the four main bearings and the oil seal diameter of the crankshaft in one plunge grind. This machine will find application in crankshaft and camshaft bearing grinding, as well as other multiple wheel applications where up to a 30in wide span of wheels can be used. Grinding wheels 42in in diameter are standard on the machine. Wheels worn to the discard size, 28in diameter by 12in hole, can be used on other grinding machines. Higher wheel speeds, up to 8500 s.f.p.m., can also be applied to the machine and will reduce the grinding cycles accordingly.

There is no sliding table on this grinder. This promotes rigid work support by allowing metal-to-metal contact between all parts from the workpiece to the one-piece base. The problem of varying thicknesses of oil film on the ways has been eliminated. Without a sliding table, end location of the workpiece is accomplished automatically by probing a locating shoulder on the workpiece and moving the entire grinding wheel spindle laterally to establish the correct work and wheel relationship. After the main bearings have been ground, the crankshaft is conveyed to the next machine, a 16in by 32in "Type CC-8 Crank-O-Matic" semi-automatic crankpin grinding machine tooled to grind each of the six crankpin diameters on the shaft. To produce crankpins with perfect fillet radii has been the objective of everyone grinding crankpins since the beginning of the piston engine. Norton now has an automatic face and radial truing device which dresses the grinding wheel with this much sought-after perfect radius on both corners of the wheel. This device is part of the pin grinder and ensures the finishing of crankpins with the exact blended radius, resulting in a stronger crankshaft.

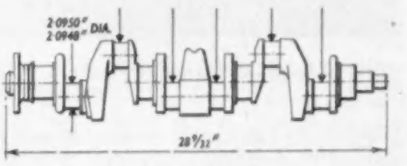
Fig. 19—Norton three-station crankshaft transfer line comprising three machines for main bearing diameter grinding, crankpin diameter grinding and lapping



Operation Data
Machine—Norton type CM-2 semi-automatic multiwheel grinder.
Part—Automotive crankshaft.
Material—Forging 250 Brinell hardness.
Operation—Finish grind main bearings and oil seal diameter.
Stock removal—0·025in on diameter.
Tolerances :

Size	0·0005in
Finish	25 to 30 microinch r.m.s.
Taper	0·0001in
Size (end to end)	0·0002in

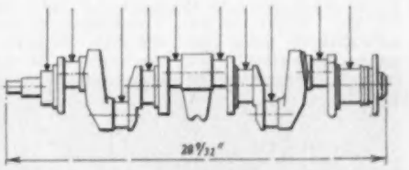
Production—Fifty-five to sixty shafts per hour.



Operation Data
Machine—Norton type CC-8 "Crank-O-Matic" crankpin grinding machine.
Part—Automotive crankshaft.
Material—Forging 250 Brinell hardness.
Operation—Finish grind crankpins.
Stock removal—0·040in on diameter.
0·008in on sidewalls.
Tolerances :

Size (diameter)	0·0003in
Shoulder width	±0·002in
Throw	±0·0005in
Taper	±0·0001in
Angularity	±0·002in
Finish	35 to 40 microinch r.m.s.

Grinding cycle per pin—Forty-five seconds.



Operation Data
Machine—Norton No. 31 "Crank-O-Lap" lapping machine.
Part—Automotive crankshaft.
Material—Forging 250 Brinell hardness.
Operation—Lap main and crankpin bearings from ground quality.
Finish required :

Main bearings	12 to 15 microinch r.m.s.
Crankpin bearings	10 microinch r.m.s.

Production—Sixty to seventy parts per hour.
This operation improves the surface finish to about one-third of the original surface finish reading.

Fig. 20 (a), (b) and (c)—Operation data

Another feature of the grinder is the "Automatic Sparksplitter." This device automatically positions the crankshaft in the workholders laterally just after the crankshaft is loaded and just before the workholders are automatically clamped. The device controls the positioning of the crankpin relative to the grinding wheel so that an equal amount of stock is removed from each crankpin wall. This is achieved even though a varying amount of stock is left on the walls or "cheeks." Equalising the stock removal ensures both walls being "cleaned up" or ground all over. With each side of the wheel doing the same amount of grinding, the wheel stays "sharp" longer and less dressing is required. Most important, the "Automatic Sparksplitter"

THE AMERICAN SCENE *(Continued)*

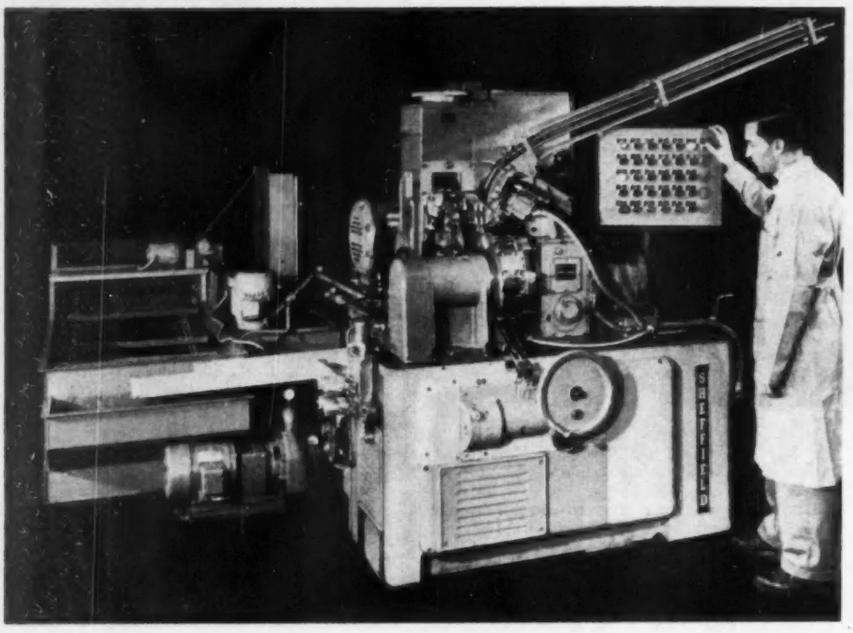


Fig. 21—Sheffield "Model 182 Crushtrue" multi-form grinding machine with automatic loading and indexing device and wheel dresser

eliminates the ridges in the crankpin cheeks that result when sparksplitting is done manually. The operator's skill formerly required is now built into the machine, and the job is done better since the crankpin is positioned before grinding.

After the main bearings and the pin diameters are ground, the shaft moves to the final station of the transfer line for final finish refinement. Here the "No. 31 Crank-O-Lap" crankshaft lapping machine refines the finish on all the bearing surfaces simultaneously. Coated abrasive paper or cloth is the finishing medium. Arms carrying the abrasive paper clamp hydraulically on each bearing diameter. The surface refining action takes place as the shaft is rotated on centres. When the job is completed on an automatically timed cycle, the arms disengage, again automatically, and the shaft is swung forward to a convenient loading and unloading position.

The Sheffield Corporation

The Sheffield Corporation, of Dayton, Ohio, presented its new "Model 182 Crushtrue" multi-form grinding machine (Fig. 21) at Chicago. The machine is designed to grind automatically cylindrical forms and grooves on two or four parts simultaneously at wheel speeds of 9200 s.f.p.m. At the exposition, two piston rod shafts, each approximately 3½in long with a ¾in diameter flange at one end of the ¼in diameter stem, were fed into a rotating cage at the front of the machine for indexing into the grinding position. Both shafts were ground simultaneously, with one being located above the centre line of the "Crushtrue" dressed grinding wheels and the other one below. Then the rotating cage indexed both parts to the unloading chute. On this application, the machine ground from the solid a ¼in wide groove to 0·0425in depth on the head of the piston rod shaft and on the stem a ⅛in wide undercut to 0·010in depth, as well as removing 0·058in stock on the diameter ¾in wide. At the same time, the machine broke three corner edges on the head and ground a chamfer on the leading edge of the head and at the end of the stem. All of this was done on the two parts in a total of six seconds floor-to-floor time. A number of these multi-form grinders are presently in use, automatically grinding similar configurations with 0·050in stock removal on 2000 automotive valves per hour.

To understand fully the grinding technique that makes this high production possible, here follows a brief description of the "Crushtrue" wheel dressing process used on this machine. The Sheffield "Crushtrue" wheel dressing process uses a formed steel or carbide roll having the same profile as desired in the workpiece to form an abrasive grinding wheel until the wheel has the reverse form of the roll. Such ground wheels plunge grind multiple forms and cylindrical grooves simultaneously from the solid or in preformed parts. They are also used to plunge and traverse grind threads. Wheel hardnesses up to the "U" range can be used on these grinders. The wheels dressing process is performed with the grinding wheel and roll operating at 250 to 300 s.f.p.m. The roll can be fed into the wheel automatically or manually on both initial forming of the wheel as well as on re-dressing. Grinding is performed by a single dressed wheel or by double wheels separated by a spacer. The rapidly rotating cage and chuckless workhead system has reduced non-productive loading and unloading time to as little as half a second for two parts.

An automatic box-type "Crushtrue" device mounted above the grinding wheel is used to form the grinding wheel as well as to re-dress it after a predetermined number of parts have been ground. The dressing cycle is fully automatic, being initiated by the grind cycle counter, which stops the high speed wheelhead motor and starts it again after the wheel has been crush dressed. The machine automatically advances the wheelhead to compensate for the amount dressed off the wheel. The frequency of wheel dressing depends on such factors as material, part configuration, wheel hardness, tolerance, etc. On grinding applications similar to the above, more than 1000 parts have been ground between wheel crushings and about 300,000 parts ground before the "Crushtrue" rolls had to be reground.

The Model 182 grinder can be used on a wide variety of parts and sizes, such as water pump shafts, snap ring grooves in needle bearing cups, and snap ring grooves and seal grooves in transmission shafts. The grinder is fully automatic, including part handling, grinding, dressing of the wheels and compensation for wheel dressing. It can also be equipped with Sheffield post-process gauging devices to initiate warning lights and signals for wheel compensation when part size trend is toward out-of-tolerance or to shut the machine down if a predetermined number of out-of-tolerance parts are produced.

The transfer of parts into and out of the grinding station is performed by a 15in diameter cylindrical cage having part slots on the outside diameter and a drive roll on the inside. Its unique design provides precision indexing at five tenths of a second. Acceleration and deceleration are smooth without abrupt starts and stops. Two parts at a time drop into the part slots and as the rotating cage indexes them into the grinding station—with one part above the centre line and the other below—clamping rolls on a pivot arm hold the parts against the steel drive roll which rotates them during grinding. In addition, the parts are end-clamped against a positive stop to obtain accurate lateral location.

Cincinnati Grinding Machine Division

An important development in the field of cylindrical grinding was the introductory display by the Grinding Machine Division of the Cincinnati Milling Machine Company, Cincinnati, Ohio, of its numerically controlled 18in by 72in cylindrical grinding machine (Fig. 22). The machine has been designed to reduce set-up time between diameters by replacing manual

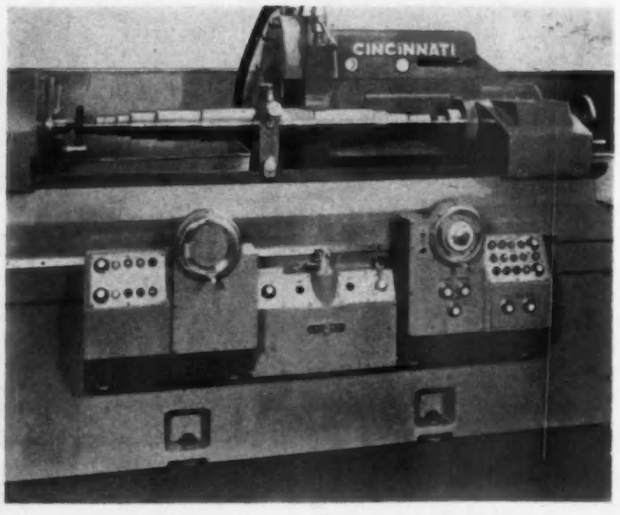


Fig. 22—Cincinnati 18in by 72in cylindrical grinding machine with "Acramatic" numerical control system

operations with programmed automatic operation. Numerical control eliminates the potential inefficiencies caused by operator tensions or fatigue. Electro-hydraulic servo controls provide highly responsive, precise movements of the wheelhead and table. In addition to automatic operation under numerical control, the machine is provided with a complete complement of manual controls designed to obtain efficient operation, with a convenient, functional arrangement of the cross feed and table traverse handwheels, control levers and electrical control buttons. Particular attention has been given to eliminating the possibility of taper caused by thermal distortion—both the hydraulic and coolant units have been isolated from the machine bed, and the headstock has been designed to place the centreline of the spindle directly over the centreline of the table vee-way. A 2 h.p. headstock motor and a 20 h.p. grinding wheel drive motor provide ample power for even the biggest jobs. The grinding wheel spindle is rigidly mounted between Cincinnati "FILM-ATIC" bearings which facilitate heaviest roughing cuts or lightest finishing cuts without adjustment. The automatic grinding wheel balancing device provides a simple means of balancing the wheel on the machine.

The new grinding machine is equipped with the highly accurate absolute "Acramatic" numerical control system developed by the Cincinnati Milling Machine Company. Since it is an absolute system of voltage ratios, variations in line voltage and external signals in no way affect the actual machine performance. The control applied to the new 18in by 72in grinding machine is two-axis rate-controlled positioning. The sequence and type of operation to be performed, table reversal points, table and wheelhead movement, truing of a predetermined amount from the grinding wheel, and cycle stops for manual operations are all numerically controlled. However, for the occasional job for which the preparation of a numerical programme is not justified, the desired diameter can be manually preselected. The operator then presses the cycle start button, and the diameter is automatically ground to the preset size. In addition to the numerically controlled methods of operation mentioned above, this machine can be utilised for traverse or automatic in-feed grinding, completely independent of tape control.

Typical of the many possible applications of the numerically controlled grinding machine is step grinding the 25 h.p. motor armature shaft illustrated in Fig. 22. The multiple diameters of this 54½in long shaft are automatically rough and finish ground, with the operator merely pressing the cycle start button. The automatic, numerically controlled positioning of the table and grinding wheel to each diameter greatly reduces conventional diameter-to-diameter set-up time, thereby reducing the cycle time and lowering the cost per piece. All functions of the grinding cycle proceed automatically under control of the data recorded on the punched tape input, ensuring consistent, efficient operation with maximum utilisation of the machine. The operator can manually select the rates of table traverse and in-feed, without modification of the tape.

The G. A. Gray Company

A fine example of the latest American practice in planer-type milling machines was demonstrated at the stand of the G. A. Gray Company, Cincinnati, Ohio. The machine (Fig. 23) provides lever-controlled extra-high spindle speeds up to 500 r.p.m. The housings, columns and rails have square lock design to absorb heavy cutting thrusts in both the forward and reverse feeding directions. The size of the milling machine is 48in by 16ft. It has a 10in quill, a 50 h.p. non-swivelling rail head, and a 5in diameter, 30in travel bar side head with 25 h.p. drive. The machine is equipped with patented non-metallic bearings on all sliding surfaces. A new attachment utilises simple dial control for making perfect spindle adjustments. The spindle tram adjusts in seconds, and spindle alignment may be adjusted as readily as spindle speeds for cutting various materials. An advanced new feature is known as power rail levelling. By pressing a button the operator can read immediately an indicator showing if the rail is level, or to what degree out of level. A pair of buttons are provided for convenient power rail levelling. The pendant station eliminates the need for control levers on the cross rail, and permits control from the normal operating position.

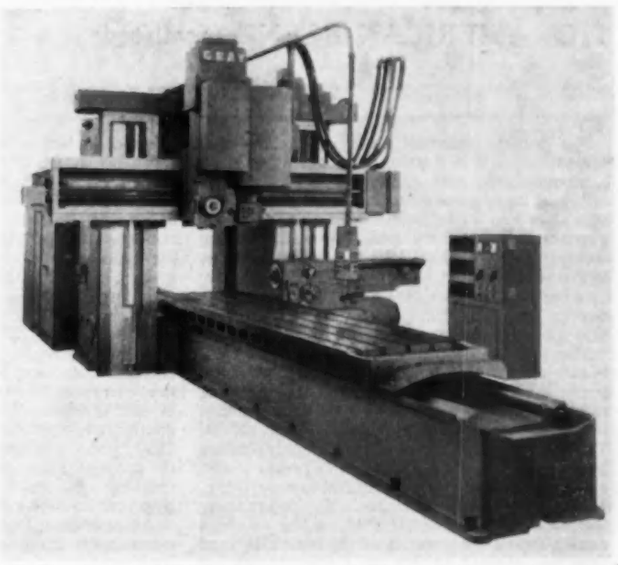


Fig. 23 — Gray 48in by 16ft planer type milling machine with "Space-Setter" system of numerical control

The milling machine was demonstrated at the Show in conjunction with the "Space-Setter" device which is manufactured by the Norden Data Systems Division of the United Aircraft Corporation. Although relatively simple, the Gray "Space-Setter" is compatible with the more sophisticated control phases. It is designed to receive later additional elements such as a comparator, tape punch and tape read-out, together with related equipment, so as to permit the conversion to full tape control. This conversion, accomplished at minimum cost in time and money, may be deferred without penalty until the technology within the customer's shop has advanced to a point to justify such action. The standard read-out exhibits large legible illuminated numbers 1in high that may be easily read from a distance of 20ft. The dimensions are preceeded by an illuminated + or − sign indicating the movement of a machine element to either side of the zero reference point. The + sign is illuminated in a green field, while the − sign is presented against a red background. Travel from a zero point in either positive or negative direction is displayed as an increasing value preceded by the appropriate + or − sign. This eliminates the need for additions and subtractions by the operator that have hitherto required time and introduced sizeable opportunity for costly error. The display reads to three decimal places for each axis and accordingly registers to a thousandth of an inch. The operator can justifiably rely on the display since one of the important characteristics of the system is that each thousandth of an inch along each axis has a discrete address. Additionally, the system is absolute in that each dimension is registered and reported from a common reference point. There is no accumulated error such as might be found in a lead screw. The electronic system has been designed so that it is completely unaffected by line voltage variations.

The zero off-set feature of the unit is of extreme importance in minimising error and reducing machine manipulating time. After the work is positioned the operator sets the centre line of the machine spindle coincident with the zero reference point of his drawing. With the flick of his control dials he sets the read-out to zero. He may then proceed from hole and from surface to surface, reading dimensions on the display or read-out that agree exactly with those of his drawing.

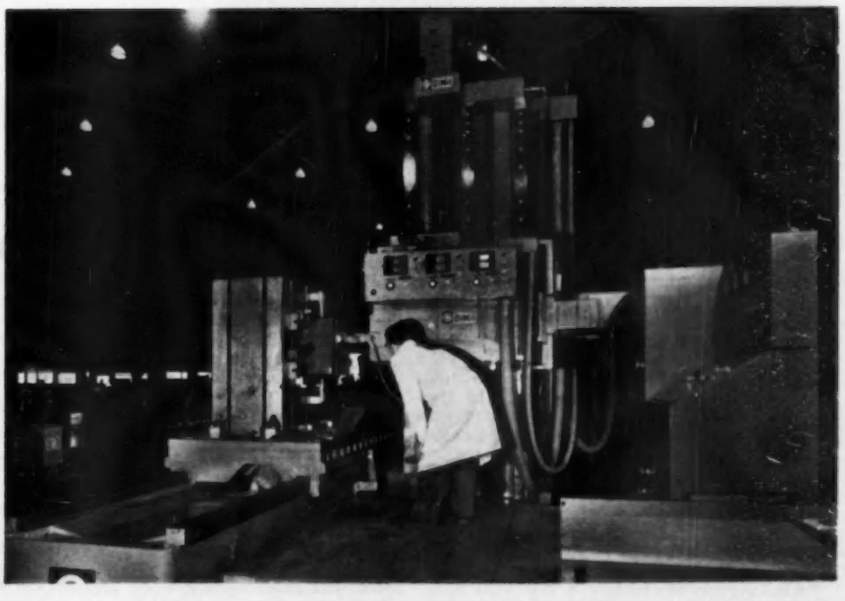


Fig. 24—Giddings and Lewis "DiMil" horizontal contour milling machine with "Numeripath" control system

THE AMERICAN SCENE *(Continued)*

The position reference along any axis of the "Space-Setter" is a precision rack. The rack is manufactured with great care in 8in lengths, with four lengths being mounted on a supporting base plate 32in long. Each 8in length of rack has a guaranteed accuracy within 0·0002in. The accuracy of the four sections composing the 32in length is guaranteed within 0·0005in. The 32in long base plates containing the rack are mounted directly on the stationary machine element. The system yields accuracies within 0·001in.

The pick-up unit or transducer is a Norden binary-coded-decimal analog-digital converter geared to the rack by a precision pinion. The unit is mounted on the moving machine element in such a way as to offer an anti-backlash action. The output of this transducer is an unambiguous binary-coded-decimal indication of position with a full six decimal digits of information available. It is thus possible to indicate dimensions ranging the 000·000in to 999·999in. The Norden analog-digital converter is of the code disk type that has proved to be an extremely reliable component under rigorous environmental conditions by its many successful applications in missile and other military systems.

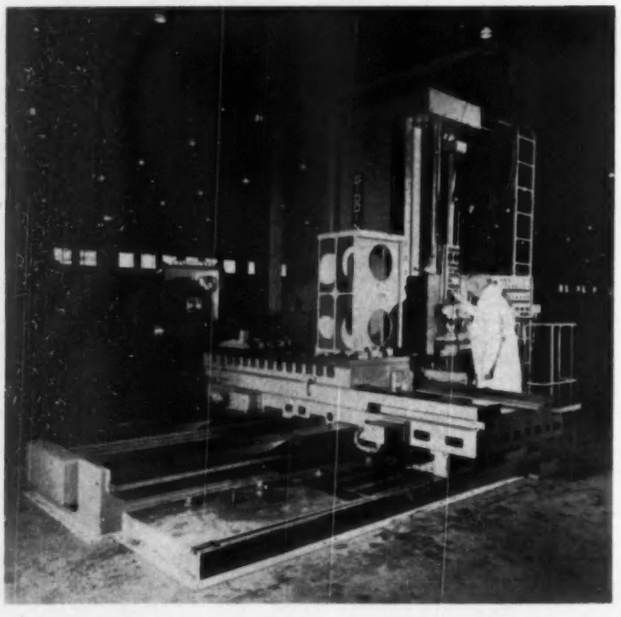


Fig. 25—Giddings and Lewis 5in spindle horizontal boring, drilling and milling machine with "Numeripoint" control system

GIDDINGS AND LEWIS MACHINE TOOL COMPANY

A total of fifteen machines were exhibited in operation at the stand of the Giddings and Lewis Machine Tool Company, Fond du Lac, Wisconsin, including five under punched paper tape discrete positioning control and one under magnetic tape path control. The latter unit was the new "No. B-20 DiMil" contour milling machine of horizontal design (Fig. 24). Because numerical control eliminates the need for templates, the advantageous horizontal milling head design can be used to eliminate the restrictions imposed by vertical machine design. The foremost benefit of horizontal construction, particularly in contour machining work, is the free fall-away of chips and coolant. This ensures free machining, superior finishes, and an unobstructed view of the work-piece and cutter at all times during the machining operations. Regardless of the size of the work-piece, milling depth capacity remains the same on a horizontal machine because the workpiece can be mounted to utilise the full depth of any feed.

Extreme rigidity is an absolute necessity for a numerically controlled machine because, if adjustments had to be made for error-producing deflection, much of the value of the automatic operations would be defeated. Hence, the numerically controlled "DiMil" is designed to be one of the most rigid contouring machines ever developed. The full-length construction of the bed eliminates overhang at the ends; wide spacing of the anti-friction ways minimises table overhang at the sides. Rigidly backing up the cutter, head and saddle is a heavy-walled column with three ways. The column is always aligned with the bed through the use of integrally cast, precision-machined keys. The machine offers thirty-two spindle speeds and an infinite number of milling feeds. The spindle speeds are evenly distributed in geometric progression from 8½ to 1800 r.p.m. The speeds are noiselessly shifted in the constant mesh gear train while the spindle is rotating. All speed changes are instantly made by power through hydraulically actuated clutches.

An important factor concerning good milling operation is the ability of the machine to blend itself into one-piece construction for maximum rigidity in the heaviest milling cuts. One of the more critical units in this construction is the quill clamp, which is located as close as possible to the actual milling cutter where it is compressed against the quill to form a solid support for milling. With a 12in head bearing and completely wrapped around the quill, the manually operated clamp is capable of exerting a large force for immobilising the quill under the high strains of heavy milling cuts.

The new machine is designed for operation by the Giddings and Lewis "Numeripath" continuous path control system. This control is available with several types of inputs to the interpolator and with a choice of interpolator location. When the interpolator is placed next to the machine, the commands are fed directly to the machine control. This is the most economical installation for a single continuous path, numerically controlled machine. When the interpolator is located remotely, several machines can be serviced from the same interpolator. Commands are recorded on magnetic tape which then becomes the input for the tape playback units attached to each machine. This is the most economical installation for an actual or contemplated multi-machine set-up because only the one interpolator is used for all machines. Magnetic tapes can be produced independently and ahead of production; thus, interpolator downtime does not affect production.

Continuous-path control systems that include the interpolating control linked directly with the machine control translate tape input data into electrical signals which are used to control the machine. This type of control can be equipped with manual feed-speed override, linear or circular interpolation, and with either binary coded tape or binary coded decimal-input tape.

With numerical control, it is necessary to know the exact position of the cutter and workpiece so that the machine can be serviced for tool-changing without losing synchronisation with the magnetic tape signals. The standard scales and verniers will show location but not with the speed and ease desired for high-production work. For faster measuring, the firm recommends replacing the scales and verniers with remote read-out decimal measuring systems.

Another interesting new machine on display was the "No. 65-H5-T" 5in spindle horizontal boring, drilling and milling machine (Fig. 25) equipped with a "Numeripoint" punched tape or dial-in control system and saddle depth positioning. This machine will automatically perform milling, positioning, boring, drilling and tapping; it also demonstrated step boring, continuous facing and full-horsepower milling at the Show. The punched tape discrete positioning system eliminates jigs and fixtures, provides automatic sequencing of operation, and ensures optimum feeds, speeds and tool life. The machine may also be equipped with automatic electric positioning which ensures precision table and headstock settings on a wide variety of applications. This system makes possible the positive, automatic vertical positioning of the spindle in the "X" axis and longitudinal positioning of the table in the "Y" axis with accuracies of ±0·0001in. Predetermined settings are established by the use of rods or end measures. The machine elements move rapidly and accurately into position without over-travel.

LANDIS TOOL COMPANY

With a total of twenty-six cylindrical, disc and surface grinding machines on display, the stand of the Landis Tool Company, Waynesboro, Pennsylvania, together with its affiliate firm, the Gardner Machine Company, Beloit, Wisconsin, was one of the major attractions of the Show. From a technical point of view, the most interesting exhibits were: (1) a tandem installation of a multiple-wheel grinder and a crankpin grinder, resulting in fully automatic crankshaft grinding and handling; (2) an automatic plunge cylindrical grinder for the single-purpose production grinding of multiple diameters, faces and shoulders; (3) a precision surface grinder with hydraulic table traverse and saddle cross-feed; and (4) a numerically controlled cylindrical grinding machine equipped with the Warner and Swasey "Probomat" tape-controlled positioning systems, and a special size-control gauging unit developed by the Airborne Instruments Laboratory, of Deer Park, New York.

In a highly unusual display of industrial censorship, the management of the Landis Tool Company withheld technical data on and photographs of this equipment from THE ENGINEER, at the same time requesting that no descriptions of the machinery be published in our pages. Certain international marketing and sales conflicts between the American parent company and its European and U.K. affiliates are said to be the reason for this strange request, which we abide by only under protest. Indeed, we would say to Mr. M. A. Hollengreen, the president of Landis, that in a world of ever closer distances and better communications, it is futile and foolish to offer technological advance to one part of the globe while withholding it from another. We can only suggest that readers interested in the developments mentioned address their own request for information directly to the firm's British affiliates, Landis Lund Limited.

(To be continued)

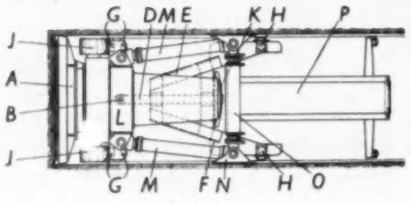
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

TUNNELLING MACHINES

852,537. August 7, 1957.—TUNNELLING MACHINES, Bade und Co. G.m.b.H., Lehrte, Hannover, Germany.

The tunnelling machine described has a forward assembly comprising a boring head *A* driven by a motor and gearbox. This forward assembly pivots about a pin *B* on a swivel mounting integral with a rigid chassis assembly comprising a tubular girder *D*, two diagonal girders *E*, a cross structure and two legs *F*. The forward assembly is supported by a cross girder with two wheels *G* at each end. The chassis assembly is partly supported by two rollers *H* fixed to the legs *F* as well as the rollers *G*. Paths in the tunnel for these rollers are cut by a rotary cutter *J*. In order to strengthen the articulation of the forward assembly on the chassis the rear end of the casing of the gearbox is fitted with a shoe *K* which is free to slide on a guide rail. The guide rail has a projection which interlocks with the shoe to prevent the forward assembly tilting on to the chassis. On both sides of the sub-assembly comprising the boring head and



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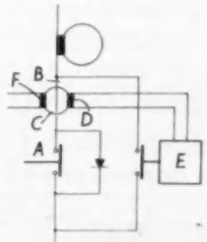
gearbox pins *L* are fixed for the articulation of two hydraulic thrust units *M* capable of independent operation. Their other ends articulate on pins with feet *N* and the extensible ends of a double hydraulic prop *O* carried on a supporting frame which articulates with the legs *F* of the chasis assembly. Thus the forward assembly (the boring head, motor and gearbox) can be swivelled about its pin *B* by pressing the feet *N* against the sides of the tunnel by the double prop *O* and then actuating the upper thrust unit *M* according to the direction required. The thrust units *M* are also used to advance the forward assembly and the chassis by extending them both together. To bore a tunnel curving upwards or downwards, the wheels *G* can be moved nearer or further away from the cross girder supporting the boring head so that the boring head can be displaced and inclined in relation to the tunnel. A scraper elevator lifts the spoil on to a conveyor belt *P* supported at its rear end by rollers which follow the tracks cut by the rotary cutter *J*.—*October* 26, 1960.

ELECTRICAL ENGINEERING

852,137. July 26, 1956.—RECTIFIER INSTALLATIONS, Siemens-Schuckertwerke Aktiengesellschaft, Berlin and Erlangen, Germany.

This invention relates to rectifier installations comprising a plurality of elements and a protective device for rendering inoperative all the rectifier elements on the occurrence of a "non-operative" reverse current. By this is meant any reverse current



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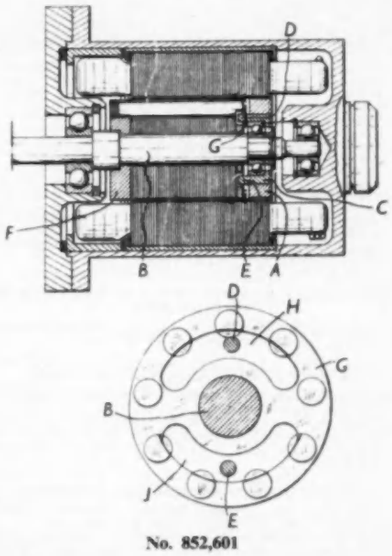
which is not set up during the normal working of the rectifier installation. The example shown in the drawing represents a phase of a mechanical rectifier installation comprising a contact device *A*, which may be either mechanically driven by eccentrically moving shafts or electro-magnetically driven. A conductor *B* leading to the contact *A* is surrounded by an iron ring *C*, the state of magnetisation of which gives an indication of the passage of non-operative reverse currents. The ring is provided with a winding *D* connected to a tripping winding of a magnetically controlled short-circuiting device *E*, so designed that it bridges the contact devices of all the operational phases of the installation simultaneously on responding. When the short-circuiting device *E* has responded, the state of magnetisation of the ring *C* cannot change again, even if a forward current should flow through the phase shown of the rectifier installation, before the opening of the main switch. The cores *C* of the different rectifier phases may each be provided with auxiliary windings *F* which serve for the subsequent determination of the direction of magnetisation. Alternatively, the current flowing through these windings directly initiates, upon back magnetisation of the said windings by means of non-operative reverse currents, a continuous signal, for example, by firing a discharge tube, tripping a hinged relay or the like.—*October* 26, 1960.

852,601. June 20, 1957.—SYNCHRONOUS ELECTRIC MOTORS, Société Steb, 6, Rue de Sebastopol, Courbevoie, Seine, France.

This invention has for its object to provide a synchronous motor incorporating a permanent magnet rotor which will start automatically under variable frequency conditions. As shown in the drawing, the motor includes a stator of the kind



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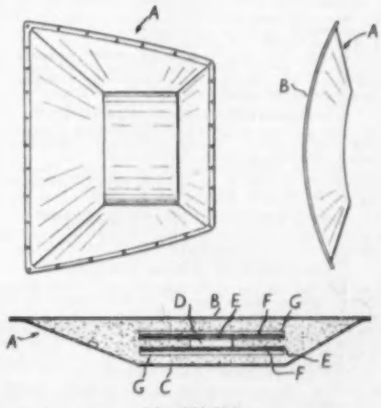
usually incorporated in induction motors. A permanent magnet *A* is rotatably fitted to the shaft *B* through the agency of a roller bearing. An intermediate member *C* including two diametrically opposed projections *D* and *E* is fitted with a tight fit between the roller bearing and the magnet. An induction rotor of squirrel cage form is secured to the shaft adjacent the magnet *A*. One of the flanges, for example the flange *F*, may be made of a resistant material, so as to give the rotor circuit an electrical resistance calculated to produce, during operation, a torque which is practically independent of the slip within a large range of values. The flange *G* registering with the magnet is made of copper and includes two arcuate slots *H* and *J* arranged symmetrically with respect to the centre of the flange *G*. The projections *D* and *E* on the intermediate member *C* fitted inside the magnet and forming a support for the latter engage the slots so as to restrict to angular movement the rotation of the magnet with respect to the induction rotor. The two sections forming the rotor, namely the permanent magnet and the actual induction rotor, show, under the action of the rotary field produced by the stator, properties which, being of substantially opposed nature, are advantageously associated. In the case of a feed voltage of high frequency, the rotary field produced by the three-phase winding at the moment at which the starting begins, assumes a high speed with respect to the magnet *A* and to the induction rotor. The starting is thus obtained under the action of the induction rotor until a speed near synchronism is reached. The magnet will be driven at the beginning through the agency of the flange *G* and of the projections *D* and *E* and will assume with respect to the induction rotor an oscillatory movement the frequency of which decreases gradually, while its amplitude increases gradually. When the speed of the rotor is near synchronism, this oscillatory movement reaches an amplitude corresponding to the length of the slot *H* or *J*. Experience has shown that these oscillatory movements allow the magnet to act on the flange through the agency of the projections *D* and *E* with more energy in the direction of rotation of the field than in the opposite direction. At a given moment, the action of the magnet will be sufficiently energetic for the movable system to be actually synchronised to synchronous speed and the induction rotor will play no further operative part. Considering the case of a field voltage at a comparatively low frequency, say ten times lower than before, the driving effort of the induction rotor will be very small, while, in contradistinction, the magnet will begin acting a long time before the synchronous speed is reached, so that the motor can start easily. In an intermediate case, starting is always obtained through the associated action of the induction rotor and the magnet, the former being predominant in the case of high frequencies and the latter being predominant in the case of low frequencies. In a practical embodiment, starting has been obtained automatically within a range of frequencies extending between 10 cycles and 200 cycles.—*October* 26, 1960.

TELECOMMUNICATIONS

852,091. April 4, 1956.—CRASH POSITION INDICATOR, National Research Council, Sussex Drive, Ottawa, Ontario, Canada.

The present invention proposes a radio beacon type of crash position indicator which is based on the concept of mounting the indicator in a broad, flat asymmetrical casing having a deploying surface oriented at an inclination to the direction of travel of the aircraft. This surface, on release of the indicator at the moment of crashing, acts to provide a drag that will convert the forward motion of the indicator, or at least a substantial part of such forward motion, to transverse motion away from the aircraft. As appears from the drawings showing



No. 852,091

one embodiment of the invention, the overall shape of the casing *A* of the indicator may be approximately that of a shallow truncated pyramid the base of which is almost a part of a cylinder but more accurately a part of a cone. The conical outer wall *B*, is shaped to replace a portion of the skin of the aircraft at the area in which the indicator is to be mounted, and the exact shape will thus vary with the aircraft design. This outer wall is generally rectangular in outside periphery and is secured to an inner wall *C* thus serving to define the space in which the radio transmitter is housed. The transmitter itself is not shown in detail but is represented by the block *D* mounted between an antenna consisting of a pair of plates *E* extending approximately parallel to the outer wall of the casing. Batteries *F* are embedded in a suitable mass *G* of foam plastic and then mounted adjacent the plate antennae *E*. After the transmitter parts have been mounted in the casing *A* formed by the walls *B* and *C*, all remaining empty spaces are filled with a pourable foam plastic of a type that will

subsequently set. This foam plastic will completely surround the parts in the casing and serve to absorb mechanical energy on impact. At the same time it will assist in providing a high strength to weight ratio to withstand aerodynamic and landing stresses and in keeping low the specific gravity of the device as a whole which should be much less than unity so that the device will float high in water. It is calculated that the device illustrated in the drawings will withstand impact with a hard surface when travelling at a speed of the order of 100ft per second without collapse or damage severe enough to prevent transmission. The method of release may consist of shear pins or the like that will allow the device to slide forward out of its socket, into the airstream on impact ; or a release mechanism operated by crash detection means.—*October* 26, 1960.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Mon., Nov. 21.—BRISTOL AND WEST OF ENGLAND BRANCH : Grand Hotel, Bristol, " Heavy Industry Control Gear," 8 p.m.
Thurs., Nov. 24.—SOUTH LONDON BRANCH : Greyhound Hotel, High Street, Croydon, Surrey, " Stage Illumination," F. E. Brown, 8 p.m.
Fri., Nov. 25.—COVENTRY AND DISTRICT BRANCH : E.M.E.B. Sports and Social Club, Merrick Lodge, Sandy Lane, Coventry, " A History of Tape Recording," G. Dawson, 7.30 p.m.

BRITISH INSTITUTE OF MANAGEMENT

To-day, Nov. 18.—Harrogate, Yorks, Conference on " Selling Capital Goods."

BRITISH INSTITUTION OF RADIO ENGINEERS

Tues., Nov. 22.—SOUTH WESTERN SECTION : School of Management Studies, Unity Street, Bristol, " Transistors in Control Circuits," E. Wolfendale, 7 p.m. ★ SOUTHERN SECTION : Technical College, Farnborough, " Radio Aids for Automatic Landing Developed by the Blind Landing Experimental Unit," J. S. Shayler, 7 p.m.
Wed., Nov. 23.—ELECTRO-ACOUSTICS GROUP : London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, " Objective and Subjective Requirements for Loudspeakers," F. H. Brittain, 6 30 p.m. ★ WEST MIDLANDS SECTION : Birmingham University, Edgbaston, Birmingham, Discussion on " The Various Routes to Professional Qualifications in Electronic Engineering," 6.15 p.m. ★ SOUTH WALES SECTION : Welsh College of Advanced Technology, Cardiff, " Radio Navigational Aids in Aircraft," 6.30 p.m.

BRITISH INTERPLANETARY SOCIETY

To-day, Nov. 18.—Royal Geographical Society's Lecture Hall, 1, Kensington Gore, London, S.W.7, One-day Joint Symposium with the Institute of Navigation, on " Space Navigation," 10 a.m.
Sat., Nov. 19.—Tudor Room, Caxton Hall, London, S.W.1, " British Participation in Space Research," D. Andrews, 6 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Tues., Nov. 22.—NORTH WESTERN REGION : Engineers' Club, Albert Square, Manchester, " Automatic Control of Coal-Fired Plant," H. B. Weston, 2.30 p m.
Wed., Nov. 23.—MIDLAND REGION : Birmingham Exchange and Engineering Centre Stephenson Place, Birmingham, 2, Discussion on " The Factories Acts in Relation to Boilers and Pressure Vessels," opened by H. Entwistle, 10.30 a.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., Nov. 21.—LEEDS CENTRE : British Lighting Council, 24, Aire Street, Leeds, 1, " Eye Strain and Glare Disabilities in Relation to Artificial Lighting," G. Black, 6.15 p.m.
Mon., Nov. 28.—BIRMINGHAM CENTRE : Regent House, St. Phillip's Place, Colmore Row, Birmingham, " Production of Light Sources," H. R. Ruff, 6 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Mon., Nov. 21.—EAST ANGLIAN SECTION : Lecture Hall, Public Library, Ipswich, " Shaw Process," Noel Shaw, 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., Nov. 22.—Memorial Building, 76, Mark Lane, London, E.C.3, " The Automatic Control of Naval Boilers," J. P. H. Brown, and W. J. R. Thomas, 5.30 p.m.
Wed., Nov. 23.—JUNIOR LECTURE : South East Essex Technical College, Longbridge Road, Dagenham, " Atomic Energy," L. Bovey, 2.30 p.m.

INSTITUTE OF METALS

Wed., Nov. 23.—MANCHESTER METALLURGICAL SOCIETY : Manchester Literary and Philosophical Society, George Street, Manchester, " New Aspects of the Electron Theory of Metals," G. V. Raynor, 6.30 p.m.
Thurs., Nov. 24.—BIRMINGHAM LOCAL SECTION : College of Technology, Gosta Green, Birmingham, " General Metallurgical Problems in the Motor Industry," R. J. Brown, 6.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Wed., Nov. 23.—NORTHERN CENTRE : Victoria and Station Hotel, Preston, " Glass Fibre Reinforced Plastics," G. O. Gurney, 7.30 p.m.
Mon., Nov. 28.—SCOTTISH CENTRE : North British Hotel, Edinburgh, " Vehicle Engine Cooling System Operation and Techniques Developed to Minimise Maintenance Cost," S. J. H. Dyson, 7.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., Nov. 22.—NORTH WESTERN BRANCH : Chemical Engineering Lecture Theatre, Manchester College of Science and Technology, Jackson Street, Manchester, 1, " New Developments in the Bulk Supply of Chemical Reagents," 3.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Nov. 22.—Great George Street, Westminster, London, S.W.1, Joint meeting with the Institution of Electrical Engineers, " The Aswan Hydro-Electric Scheme," V. Furuskog and G. Kennedy, 5.30 p.m.
Thurs., Nov. 24.—INFORMAL DISCUSSION : Great George Street, Westminster, London, S.W.1, " The Operation of the General Conditions of Contract for Works of Civil Engineering Construction," introduced by A. M. Holbein, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, Nov. 18.—NORTH STAFFORDSHIRE SUB-CENTRE : Technical College, Stoke, " Radiocommunication in the Power Industry," E. H. Cox and R. E. Martin, 7 p.m.
Sat., Nov. 19.—LONDON GRADUATE AND STUDENT SECTION : Visit to Tower Bridge, 3 p.m.
Mon., Nov. 21.—NORTH-EASTERN CENTRE : Neville Hall, Westgate Road, Newcastle upon Tyne, " Radiocommunication in the Power Industry," E. H. Cox and R. E. Martin, 6.15 p.m. ★ SHEFFIELD SUB-CENTRE : Angel Hotel, Brigg, " Subscriber Trunk Dialling," D. A. Barton, to be read by H. E. Francis, 7 p.m. ★ NORTH WESTERN CENTRE EDUCATION DISCUSSION CIRCLE : Engineers' Club, Manchester, Discussion on " The Teaching of Electrical Network Theory and its Applications in Electrical Engineering," opened by F. E. Rogers, 6.15 p.m. ★ WESTERN SUPPLY GROUP : South Wales Institute of Engineers, Park Place, Cardiff, Films, 6 p.m. ★ WESTERN UTILISATION GROUP : S. Western Electricity Board Demonstration Theatre, Old Bridge, Bath, " The Characteristics and Protection of Semiconductor Rectifiers," D. B. Corbyn and N. L. Potter, 6 p.m. ★ READING DISTRICT BRANCH : George Hotel, King Street, Reading, " Electronics in the Postal Mail Services," G. F. Copping, 7.15 p.m. ★ LONDON GRADUATE AND STUDENT SECTION : Savoy Place, London, W.C.2, " Magnetic Amplifiers in Power Engineering," M. J. Pope, 6.30 p.m.
Tues., Nov. 22.—Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1, Joint meeting with the Institution of Civil Engineers, " The Aswan Hydro-Electric Scheme," V. Furuskog and G. F. Kennedy, 5.30 p.m. ★ NORTH-WESTERN SUPPLY GROUP : Engineers' Club, Manchester, " The Logical Design of Electrical Networks using Linear Programming Methods," U. G. W. Knight, 6.15 p.m.
Tues. to Thurs., Nov. 22 to 24.—ELECTRONICS AND COMMUNICATIONS SECTION : Savoy Place, London, W.C.2, Conference on " Electronic Telephone Exchanges," 5.30 p.m.
Wed., Nov. 23.—SOUTH-WEST SCOTLAND SUB-CENTRE : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, " A Survey of Street Lighting and Its Future," W. R. Stevens and H. M. Ferguson, 6 p.m. ★ SOUTHERN CENTRE : Central Electricity Generating Board Offices, 111, High Street, Portsmouth, " Applications of Operational Research Techniques to C.E.G.B. Plant Problems," A. W. Ingram, 6.30 p.m.
Thurs., Nov. 24.—CAMBRIDGE ELECTRONICS AND MEASUREMENT GROUP : Cavendish Laboratory, Cambridge, " Television Recording : A Survey of the Problems and Methods Currently in Use," J. Redmond, 8 p.m. ★ SOUTH MIDLAND CENTRE EDUCATION DISCUSSION CIRCLE : College of Advanced Technology, Birmingham, Discussion on " The Study of Non-Linear Circuits at Under-Graduate Level," opened by D. G. Tucker, 6 p.m.
Sat., Nov. 26.—LONDON GRADUATE AND STUDENT SECTION : Visit to Strand Electric and Engineering Company, Ltd., 2.30 p.m.
Mon., Nov. 28.—ARBORFIELD DISTRICT MEETING : Unit Cinema, 3 (Tels.) Training Bn., R.E.M.E., Arborfield, Berks., Film Evening, 7 p.m. ★ EDUCATION DISCUSSION CIRCLE : Savoy Place, London, W.C.2, Discussion on " Training for Research," opened by G. H. Rawcliffe and G. A. V. Sowter, 6 p.m. ★ EAST ANGLIAN SUB-CENTRE : Electric House, Ipswich, " An Introduction to Electronic Computers," R. C. M. Barnes, 6.30 p.m. ★ MERSEY AND NORTH WALES CENTRE : Royal Institution, Colquitt Street, Liverpool, " Thermistors—Their Theory, Manufacture and Application," R. W. A. Scarr, and R. A. Setterington, 6.30 p.m. ★ SOUTH MIDLAND ELECTRONICS AND MEASUREMENT GROUP : James Watt Memorial Institute, Birmingham, " Static Switching," G. L. Butcher, 6 p.m. ★ NORTH STAFFORDSHIRE SUB-CENTRE : Mechanical Institute, Crewe, " A Survey of Street Lighting and its Future," W. R. Stevens and H. M. Ferguson, 7 p.m. ★ WESTERN UTILISATION GROUP : S. Western Electricity Board Lecture Theatre Centre, Bristol, " Discrimination between H.R.C. Fuses," E. Jacks, 6 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Nov. 29.—39, Elmbank Crescent, Glasgow, Informal meeting, " Does Prefabrication Pay?." 6.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

Fri., Nov. 25.—NORTHERN BRANCH : Union Hall, Whitehaven, " Bridges in the West Riding, with particular reference to the Wentbridge Viaduct," N. H. Buchi, 7 p.m. ★ NORTH EASTERN BRANCH : University of Durham Science Laboratories, Durham City, " Highway Design," W. S. Hydes, and A. W. Jacomb, 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Nov. 18.—SCOTTISH BRANCH : Technical College, Dundee, " Corrosion Fatigue," A. W. Scott, 7.30 p.m.
Tues., Nov. 22.—LUBRICATION GROUP : 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on " Bearing Corrosion," 6 p.m. ★ EASTERN BRANCH : Dujon Restaurant, Bedford, " Developments in High Nickel Alloys for Heat and Corrosion Resistance," J. Hinde, 7.30 p.m. ★ RUGBY SUB-BRANCH : College of Engineering Technology, Rugby, Repetition of the James Clayton Lecture, " The Future of Air-Breathing Engines in Aviation," S. G. Hooker, 6.30 p.m. ★ SCOTTISH GRADUATES' SECTION : South Engineering Building, The University, Glasgow, " Some Aspects of the Design of Feed Heaters," I. C. Finlay, 7.30 p.m. ★ SOUTHERN GRADUATES' SECTION : Grand Hotel, Brighton, " The Dragon Reactor Experiment," G. E. Lockett, 7.30 p.m.
Wed., Nov. 23.—ORDINARY MEETING : 1, Birdcage Walk, Westminster, London, S.W.1, " Blaenau Ffestiniog and Other Medium-Head Pumped Storage Schemes in Great Britain," H. Headland, 6 p.m. ★ SOUTHERN BRANCH : Apprentices' Training School, Vickers-Armstrongs, Ltd., Weybridge, Joint meeting with the Royal Aeronautical Society, " The Art of Developing Aero-Engines," A. C. Lovesey, 6.10 p.m.
Thurs., Nov. 24.—NORTH EASTERN BRANCH : Stephenson Building, Claremont Road, Newcastle upon Tyne, " Relation between the Critical Alternating Propagation Stress and Crack Length for Mild Steel", N. E. Frost, 6.15 p.m.
Fri., Nov. 25.—NORTH EASTERN GRADUATES' SECTION : Rutherford College, Newcastle upon Tyne, " Photoelasticity," R. Stead, 6.30 p.m.
Mon., Nov. 28.—YORKSHIRE BRANCH : Afternoon visit to Hepworth and Grandage, Bradford : Institute of Technology, Bradford, " Planned Maintenance," W. Jones, 7.15 p.m. ★ SOUTHERN GRADUATES' SECTION : All day visit to Vauxhall Motors, Ltd., Luton.

INSTITUTION OF PLANT ENGINEERS

Thurs., Nov. 24.—MERSEYSIDE AND N. WALES BRANCH : The Blossoms, Chester, " Breakdowns—Another Year of Case Histories," J. Sword, 7.15 p.m. ★ SHEFFIELD AND DISTRICT BRANCH : Grand Hotel, Sheffield, " The Introduction of Planned Maintenance Systems," A. F. Stedman, 7.30 p.m.
Fri., Nov. 25.—BIRMINGHAM BRANCH : Imperial Hotel, Temple Street, Birmingham, " British Railways Electrification Scheme," W. B. Marrian, 7.30 p.m.
Mon., Nov. 28.—WEST AND EAST YORKSHIRE BRANCH : Houldsworth School of Applied Science, The University, Leeds, " The Building of a Modern Oil Tanker," W. S. Brown, 7.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Nov. 21.—SHEFFIELD GRADUATE SECTION : Samuel Fox and Co., Ltd., Stocksbridge Works, Near Sheffield, " Machine Tool Lubrication," A. E. Annable, 7 p.m.
Fri., Nov. 25.—NORTH MIDLANDS REGION : Louis Room, St. James Restaurant, St. James Street, Derby, " Developments in Dimensional Accuracy," K. J. Hume, 7 p.m.
Mon., Nov. 28.—NORTH WESTERN REGION : Reynolds Hall, Manchester College of Science and Technology, Manchester, " Machine Tool Development as Seen at Olympia, 1960," Norman Stubbs, 7.15 p.m. ★ EAST AND WEST RIDINGS REGION : Grand Hotel, Grosvenor Room, Sheffield, " Membership Qualifications," H. W. Hodson, 6.30 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Wed., Nov. 23.—WEST OF ENGLAND SECTION : Royal York Hotel, Bath, Joint meeting with the Plastics Institute, " Colours —Their Uses and Developments," H. G. White, 8 p.m.
Thurs., Nov. 24.—HUMBERSIDE SECTION : Hammonds Restaurant, Hull, " The Trend of Polymer Developments for the Rubber Industry," L. Mullins, and W. C. Wake, 8 p.m.
Mon., Nov. 28.—MANCHESTER SECTION : Engineers' Club, Albert Square, Manchester, " Casting in the Rubber Industry," G. P. Slater, 6.45 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Fri., Nov. 25.—MIDLAND COUNTIES BRANCH : Byng Kendrick Suite, College of Advanced Technology, Gosta Green, Birmingham, 6, " The Architect and the Developer," J. Seymour Harris, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Nov. 18.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, Chairman's Address, " Simple Instruments for Tanks and Pipelines," E. M. Baskerville, 7 p.m.
Fri., Nov. 25.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, Annual General Meeting, 7 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

To-day, Nov. 18.—Lecture Theatre, Mining Institute, Neville Hall, Newcastle upon Tyne, Symposium on " Reorganisation of Some Tyneside Shipyards," 6.15 p.m.

PLASTICS INSTITUTE

Mon., Nov. 21.—City of London College, Moorgate, London, E.C.2, " The Future," V. E. Yarsley, 6.15 p.m.
Tues., Nov. 29.—Empire Restaurant Hall, Olympia, London. Symposium on " Plastics and Corrosion," 2.15 p.m.

REINFORCED CONCRETE ASSOCIATION

Tues., Nov. 22.—MIDLAND COUNTIES BRANCH : Birmingham and Midland Institute, Paradise Street, Birmingham, " Brazil, Venezuela and Mexico," A. J. Gordon, 6 p.m.

ROYAL AERONAUTICAL SOCIETY

To-day, Nov. 18.—SIXTEENTH BRITISH COMMONWEALTH LECTURE : Institution of Mechanical Engineers, 1, Birdcage Walk, London, S.W.1, " The Story of Indian Air Transport," J. R. D. Tata, 6 p.m.
Mon., Nov. 21.—Institution of Mechanical Engineers, 1, Birdcage Walk, London, S.W.1, " My First Ten Years in Aviation," Sir Thomas Sopwith, 6 p m.
Tues., Nov. 22.—Library, 4, Hamilton Place, London, W.1, " Basic Considerations of V/STOL Aircraft," P. L. Sutcliffe, 7 p.m.
Wed., Nov. 23.—Library, 4, Hamilton Place, London, W.1, " The British Space Programme," M. O. Robins, 7.30 p.m.
Mon., Nov. 28.—Library, 4, Hamilton Place, London, W.1, " The Farmer's Viewpoint," J. B. Farrant, 7 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Sat., Nov. 26.—MINING SURVEYORS GENERAL MEETING : Welbeck Hotel, Nottingham, " Offshore Mineral Exploration," R. H. Garnett, 10.30 a.m.

ROYAL SOCIETY OF ARTS

Wed., Nov. 23.—John Adam Street, Adelphi, London, W.C.2, " Learning to Read : An Experiment," I. J. Pitman, 2.30 p.m.

ROYAL STATISTICAL SOCIETY

Mon., Nov. 21.—BIRMINGHAM GROUP : Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, 2, " Public Opinion Polls," C. A. Moser, 6.15 p.m. ★ EDINBURGH GROUP : Chamber of Commerce, 25, Charlotte Square, Edinburgh, " Statistical Methods as Aids to Business Management," T. Hunter-Thomson, 7.30 p.m.
Wed., Nov. 23.—GLASGOW GROUP : Royal College of Science and Technology, Glasgow, C.1, " Some Problems of Sampling for Large-Scale Enquiries," P. J. Lane, 7.30 p.m.

SOCIETY OF ENVIRONMENTAL ENGINEERS

Wed., Nov. 23.—Imperial College, Exhibition Road, London, S.W.7, " Vibration Testing and Instrumentation of Large Stores," 6 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., Nov. 22.—CHELTENHAM SECTION : Belle Vue Hotel, Cheltenham, " The Operation and Control of ERNIE," 7.30 p.m.
Thurs., Nov. 24.—CHESTER SECTION : Lecture Theatre, Administration Building, The Associated Ethyl Company, Ltd., Oil Sites Road, Ellesmere Port, Wirral, " Maintenance and Operational Experience of a Data Logging Installation," D. C. Austin, 7 p.m.
Fri., Nov. 25.—SCOTTISH SECTION : The University, Glasgow, " Instrumentation of a Space Vehicle," A. E. Roy, 7.15 p.m.

TELEVISION SOCIETY

Fri., Nov. 25.—Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2, " Measurement Techniques for Television Broadcasting," L. E. Weaver, and I. J. Shelley, 7 p.m.

UNIVERSITY OF LONDON

To-day, Nov. 18.—University College, Chemistry Lecture Theatre, Gower Street, London, W.C.1, " The History of the Petroleum Industry," R. J. Forbes, 5.30 p.m.

UNIVERSITY OF LONDON, KING'S COLLEGE

Wed., Nov. 23.—Strand, London, W.C.2, " Vibration Mills and Vibration Milling," Part 3, H. E. Rose, 5.30 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

To-day, Nov. 18.—39, Elmbank Crescent, Glasgow, " Selection, Testing and Use of Steel for Caterpillar Tractors," W. Sellars and W. J. Cormack, 6.45 p.m.

NICKEL ALLOY STEELS

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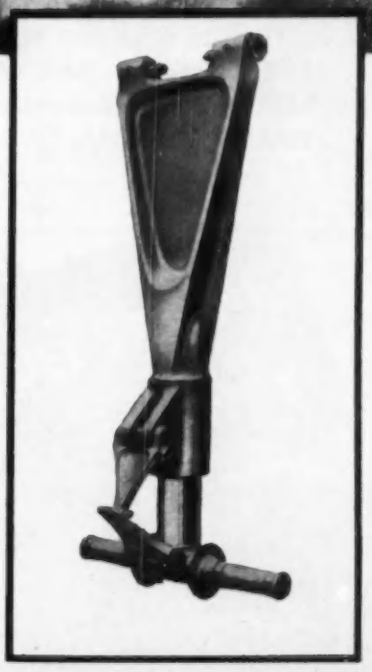
Weight saving is essential in aircraft designs and in choosing the steels for their retractable undercarriages, the Dowty group at Cheltenham turned to well-tried steels based on nickel, chromium and molybdenum, which offer attractive strength/weight ratios.

These steels, which are covered by S95, S97 and S99 aircraft specifications (industrial near equivalents are En24, En25 and En26 respectively), have high tensile values which permit dimensions, notably cylinder wall thickness, to be reduced to a minimum. Ductility measured in percentage elongation, remains adequate.



By utilising the better properties obtainable in more highly alloyed nickel alloy steels, dimensions can be reduced, lighter constructions produced, distortion through heat treatment minimised and reliability and economy achieved.

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EN26 *ARE GIVEN BELOW:*

SIZE	HEAT TREATMENT	Yield Stress t.s.i.	Maximum Stress t.s.i.	Elongation per cent	Izod ft. lb.
4" sq.	Oil quenched 830°C. tempered 650°C.	64	69	20	52
2" dia.	Oil quenched 830°C.	60	70	20	53
6" sq.	Oil quenched 830°C. tempered 590°C.	62	71	18	39

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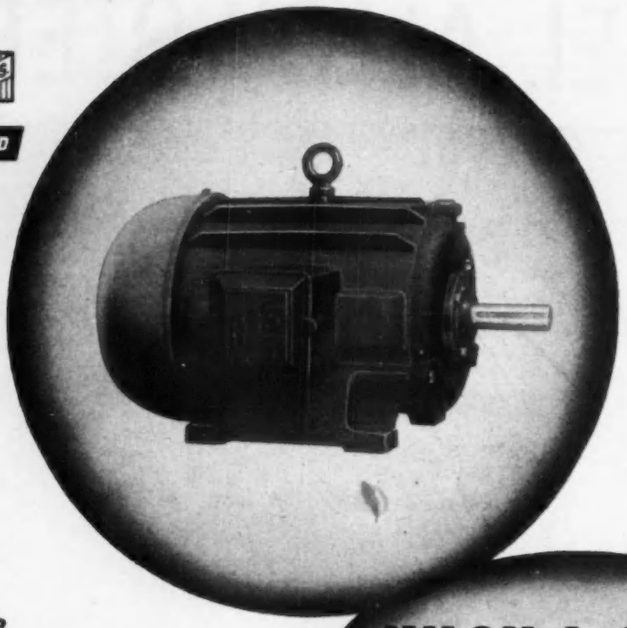

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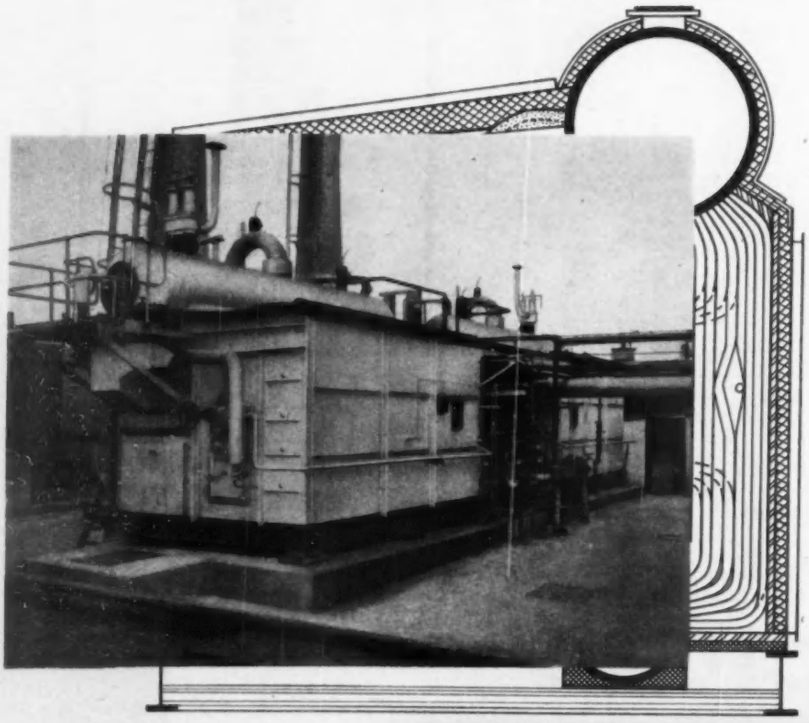

of steam can be provided by Foster Wheeler Package Boilers. These boilers are of water tube design and can be arranged for semi or fully automatic operation. Factory assembled as complete units they require simple foundations only, each unit being semi-portable

Units are being operated to provide steam pressures to 1,200 p.s.i. and final steam temperatures to 865°F. Drum internals can be fitted to permit a steam purity guarantee of 1 p.p.m. solid carry-over when boiler water is maintained within approved concentrations. Superheaters can be provided which are of the fully drainable type and easily withdrawn for maintenance purposes.

The illustration shows a typical installation of three Foster Wheeler Packaged Boilers installed for the Esso Petroleum Company at Trafford Park. Each Boiler providing steam at 14,000 lb/hr with a steam pressure of 200 p.s.i.g. at 450°F.

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saves steam—saves time

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The **Crockatt**
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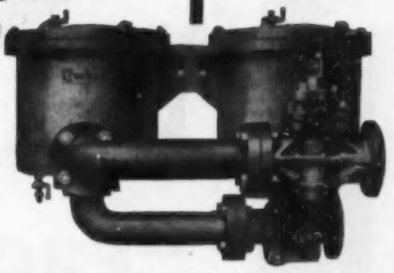
Also: Electric Salinometers, Boiler Tube Brushes, Floor Sanders, Terazzo Surfacers, etc. List on request



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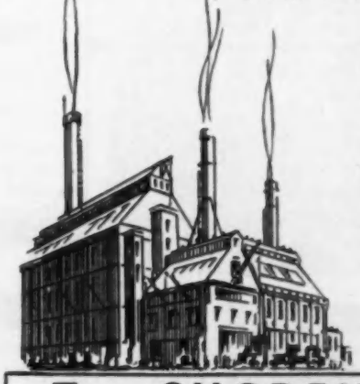

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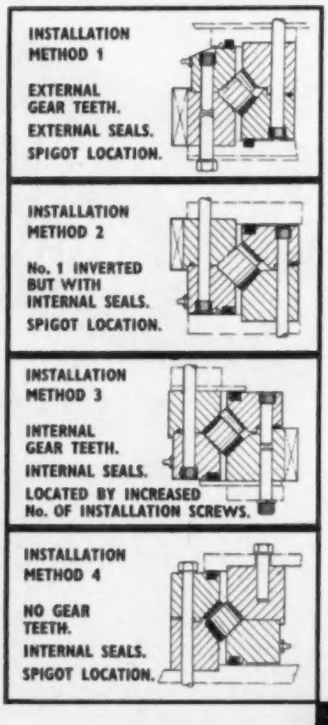

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The bearing is supplied assembled, pre-loaded and lubricated, only fitting in position is required.

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This leaves a large area on centre line free to accommodate controls, power cables and other services.

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The principle of twin paths and pre-loaded cross rollers effectively interlocks crane superstructure and base, eliminating "rock".

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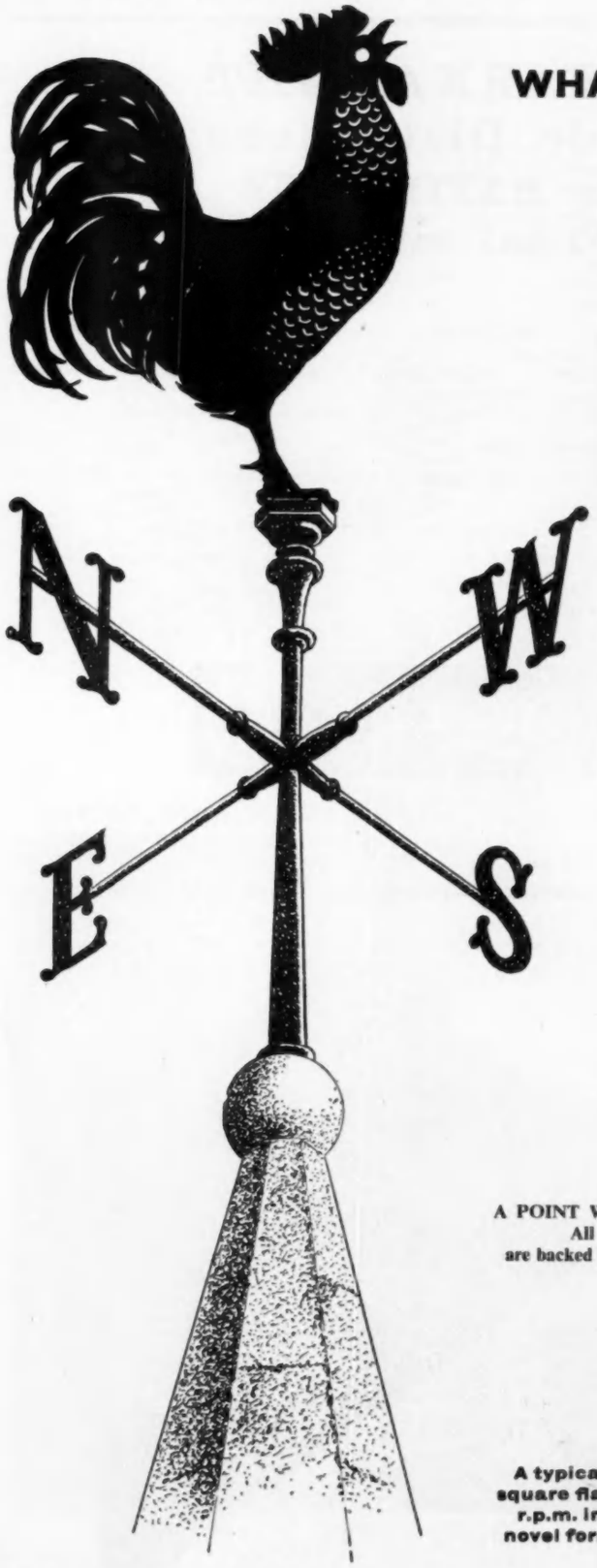

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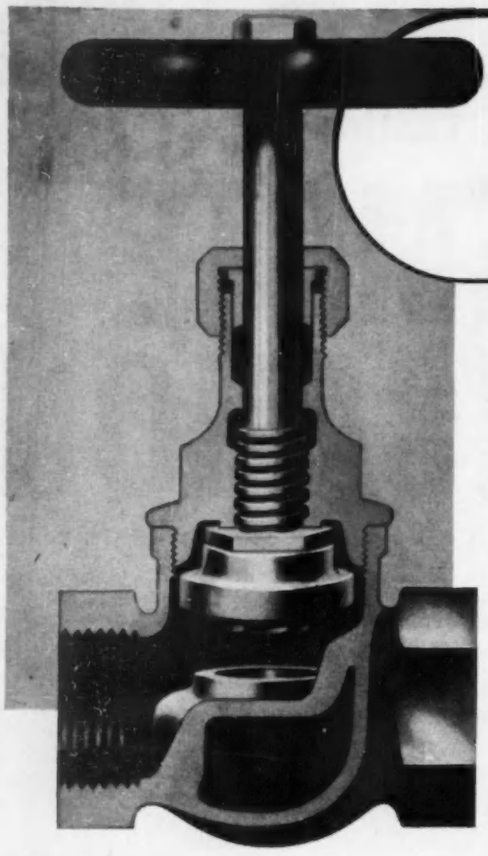

Fig. 13

FEARNAUGHT
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for 180 p.s.i. saturated steam

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Above : Welded Plate Girder Railway Bridge for London Transport Executive, erected in our works for inspection. Span of Girders 70 ft. Photo by courtesy of British Railways L.T.E.

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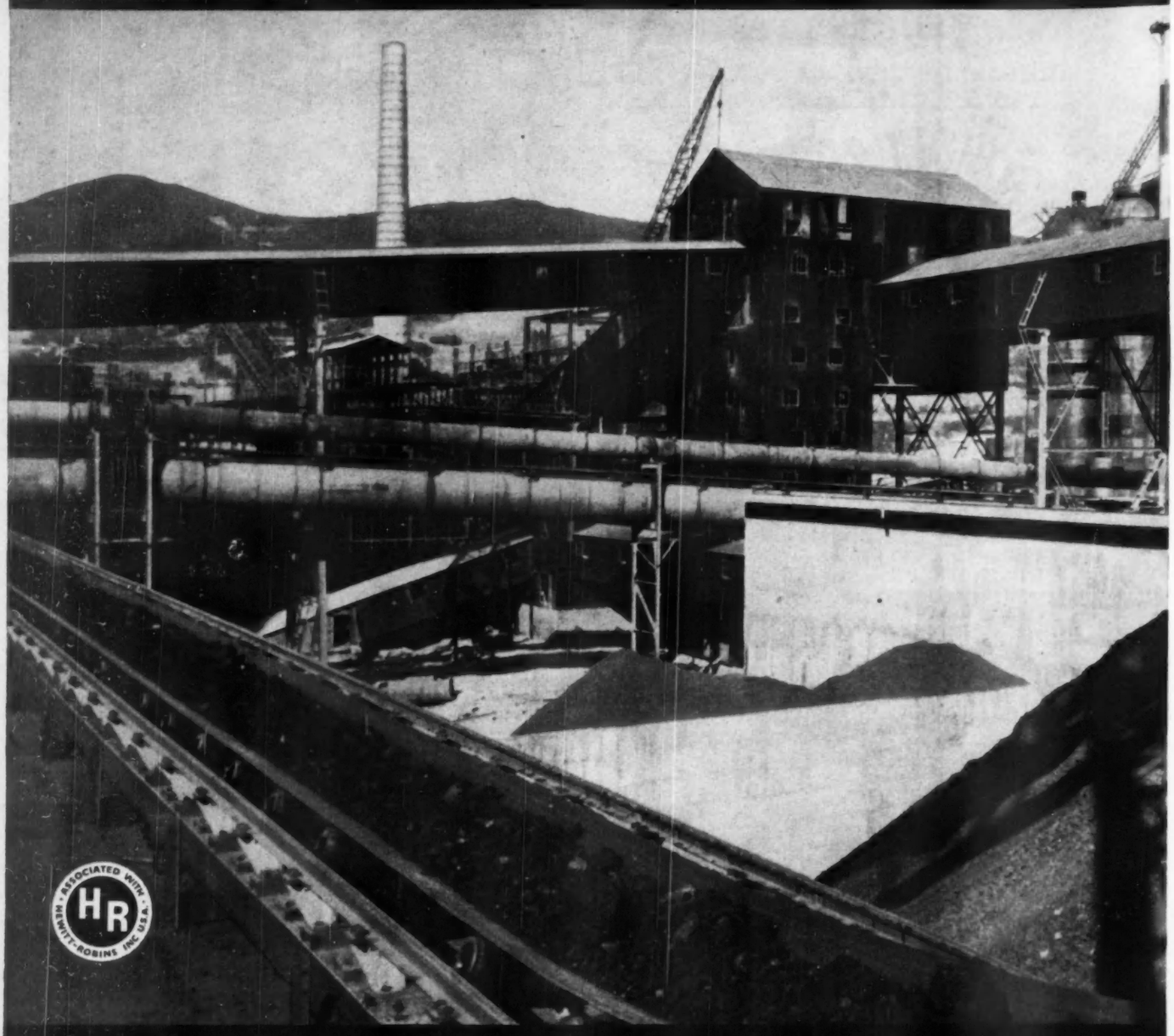

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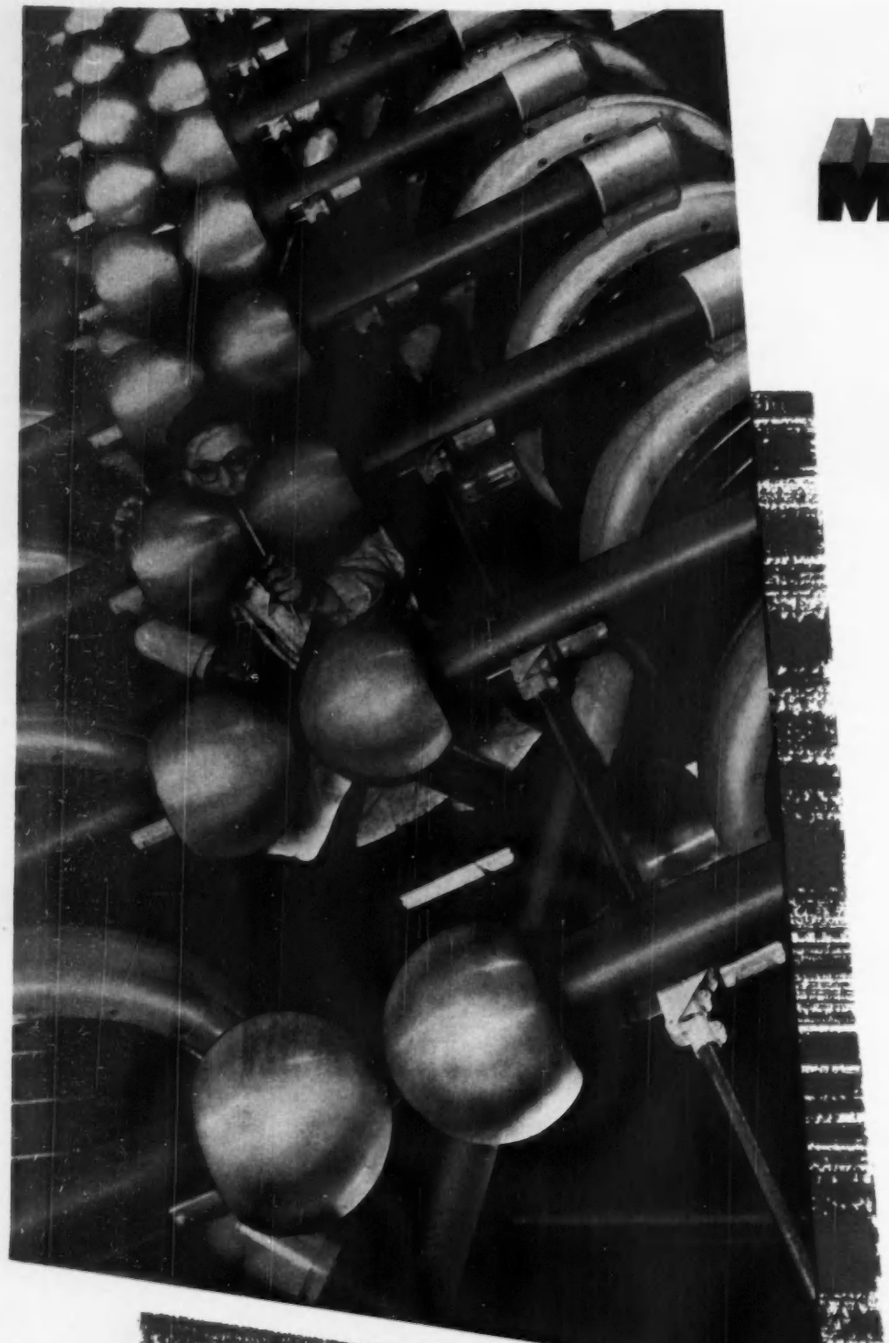

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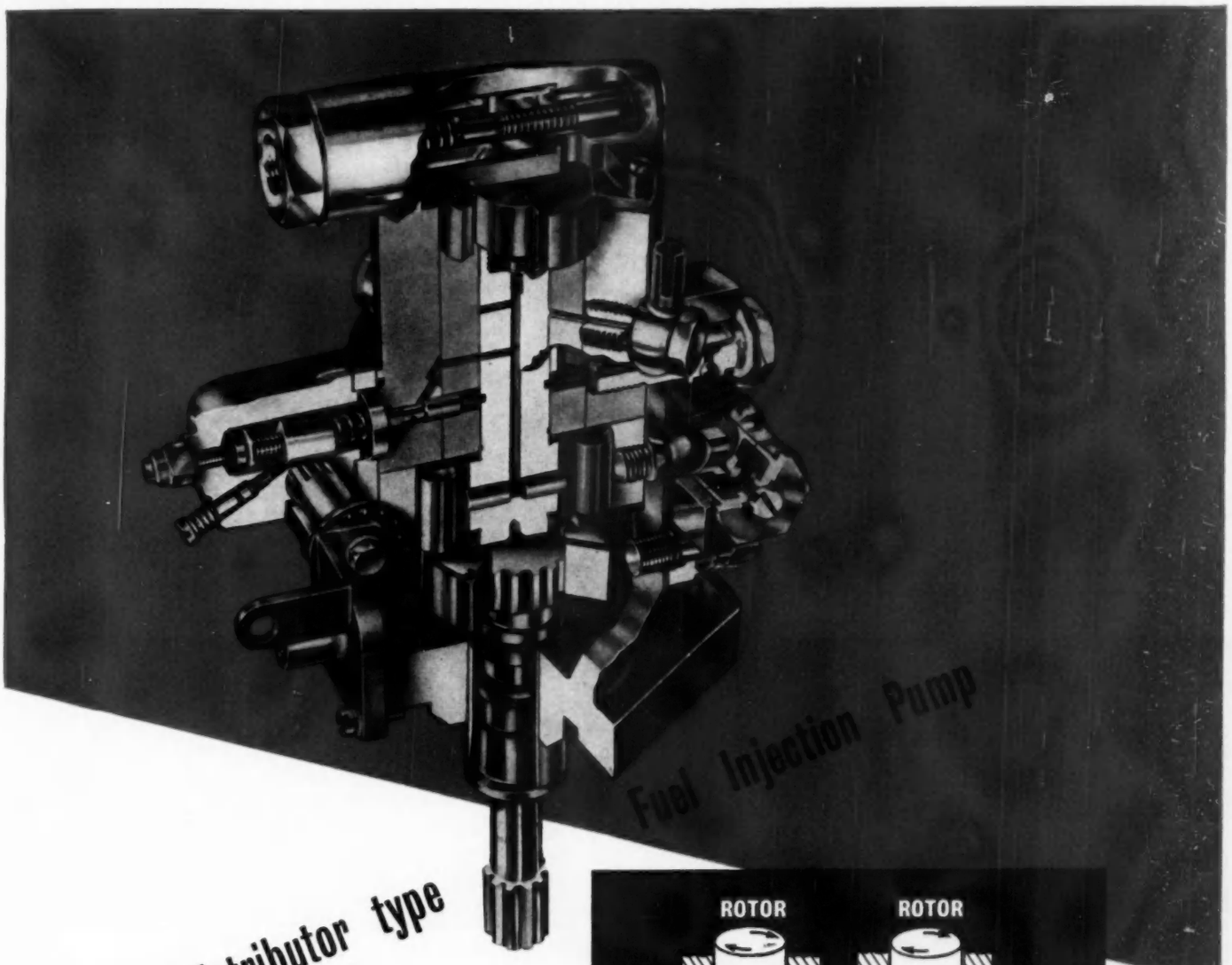
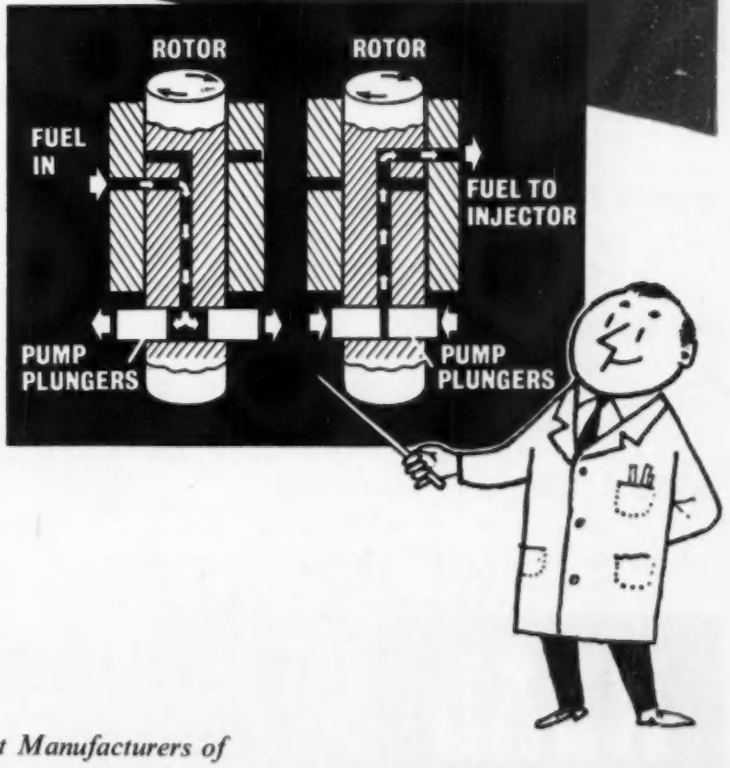


The Distributor type



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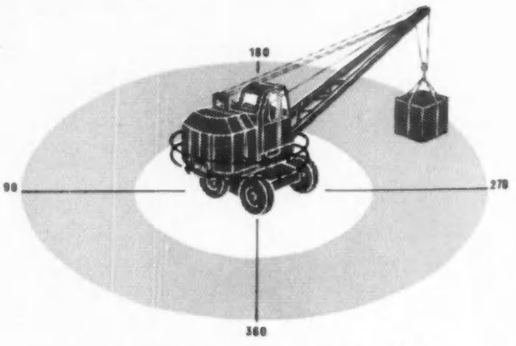

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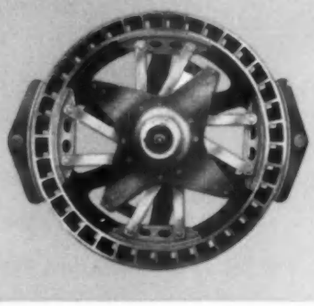

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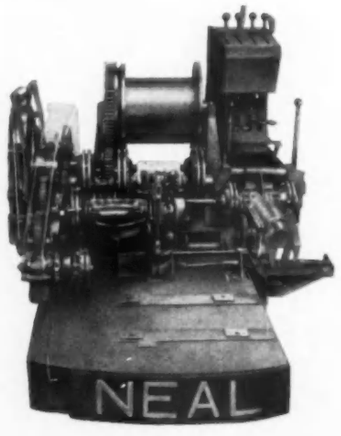

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*55	720	50	730
70	720	65	1475
*75	970	†65	1475
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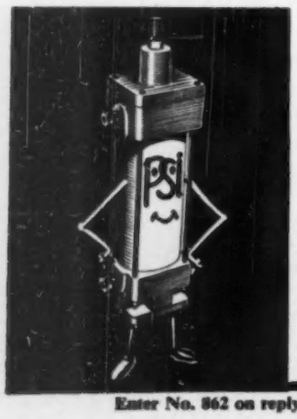

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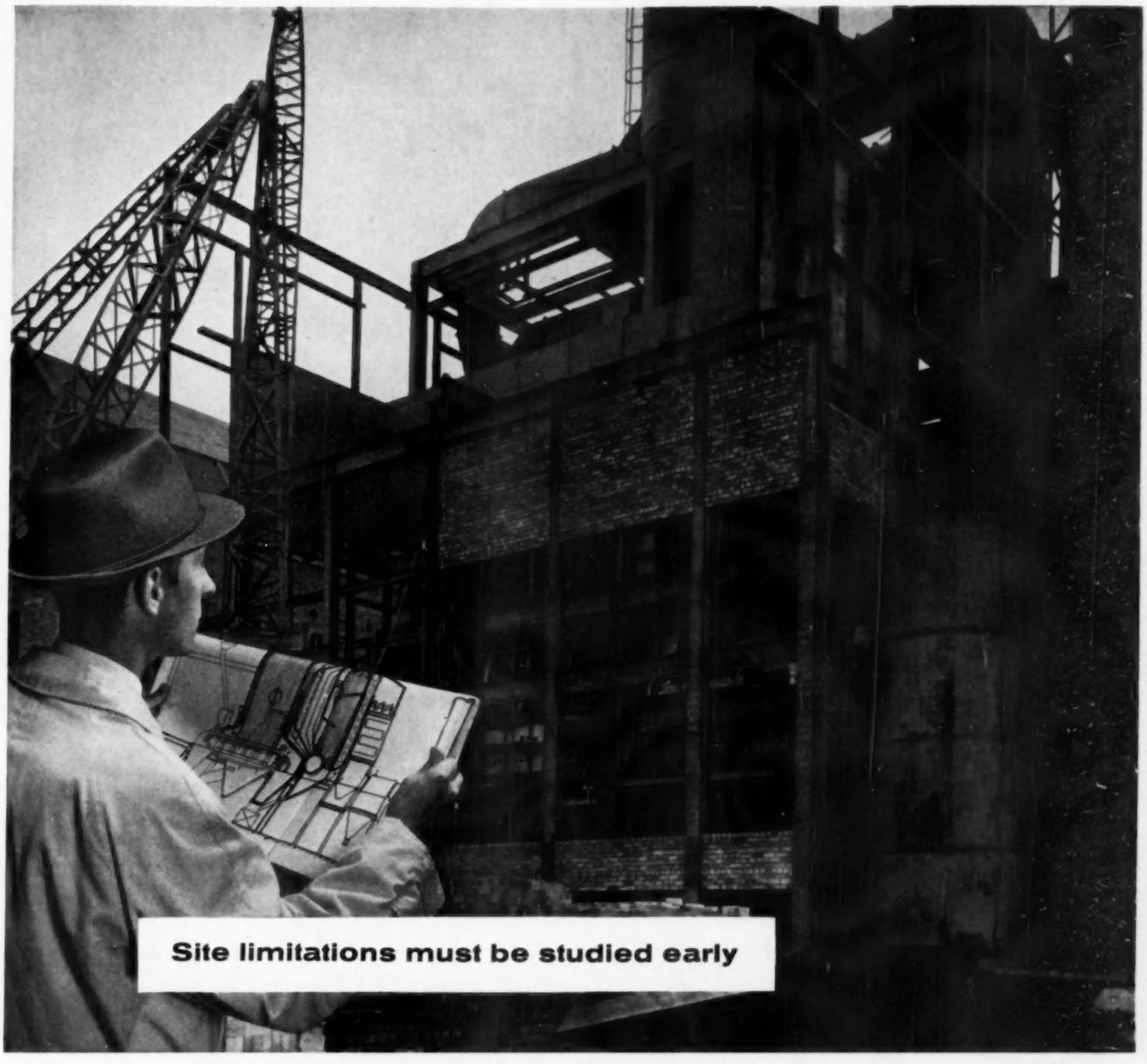

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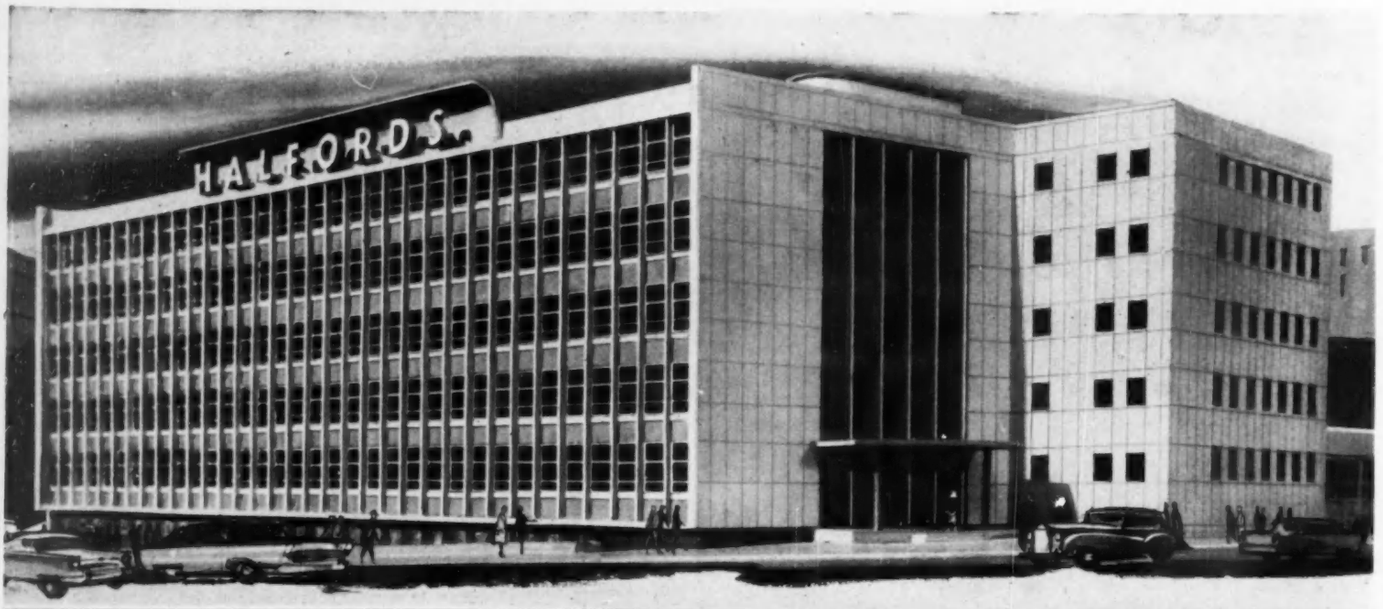

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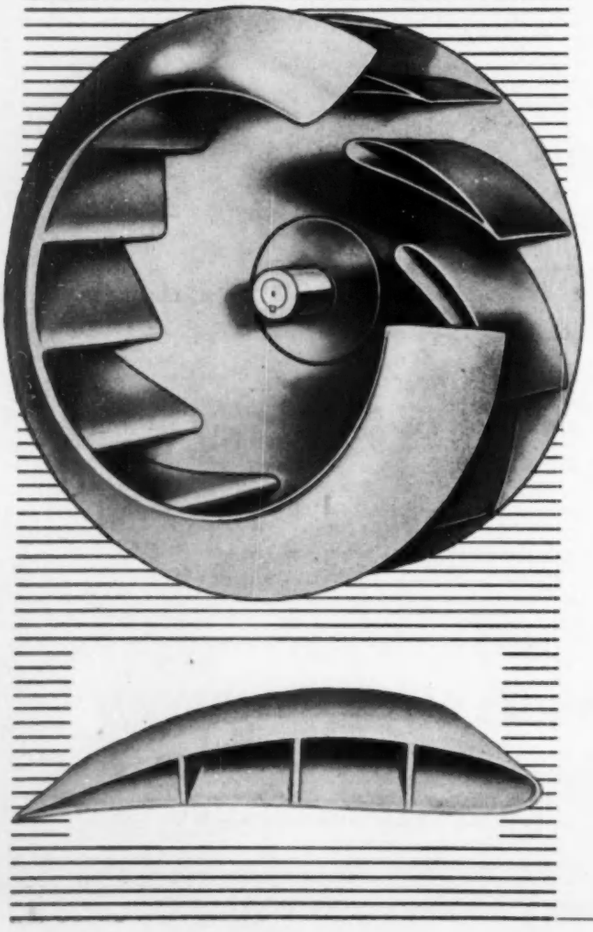

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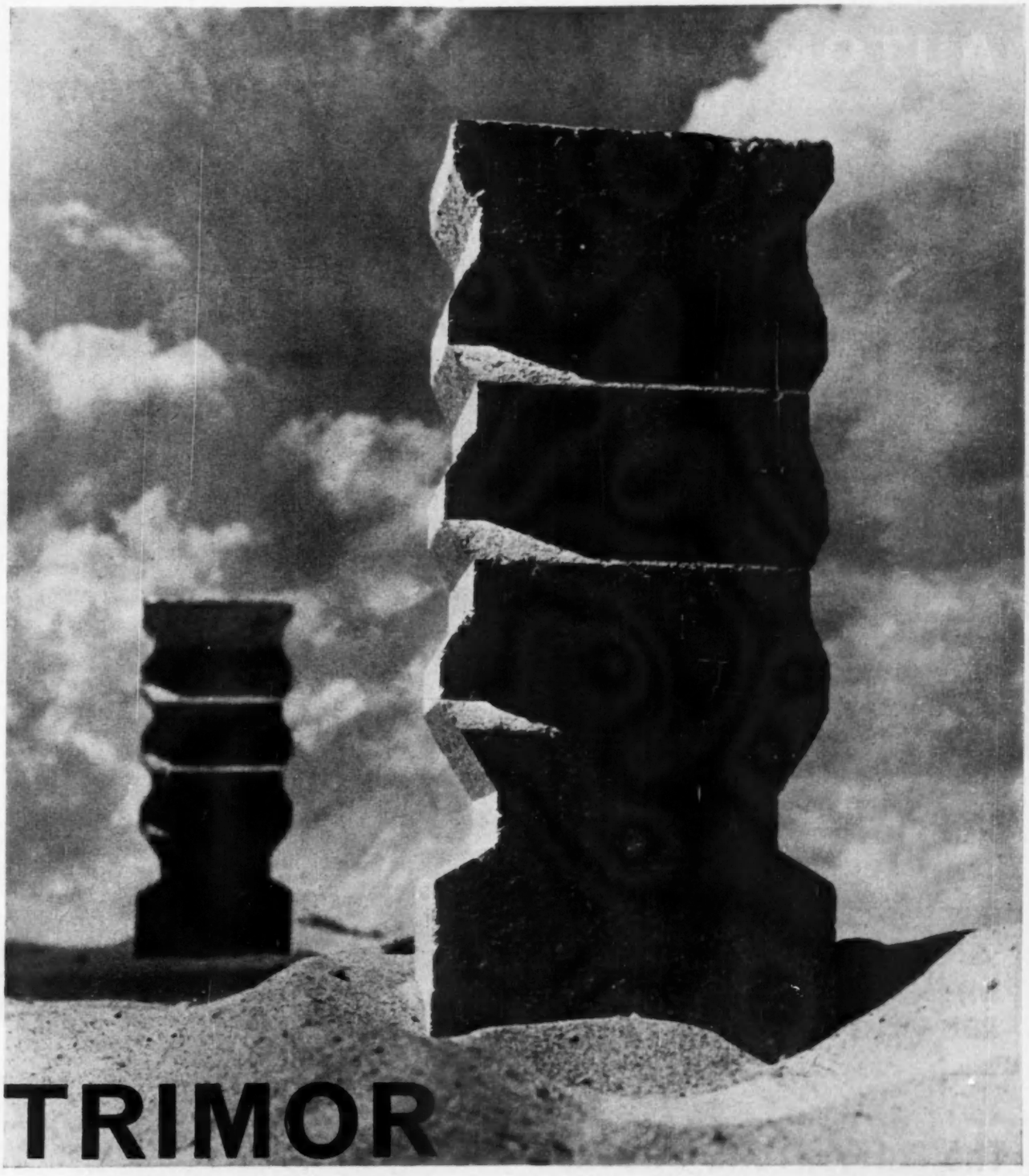

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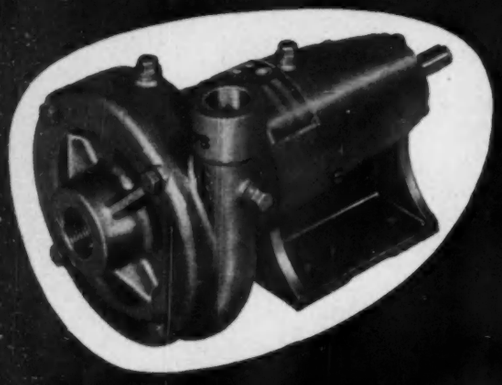

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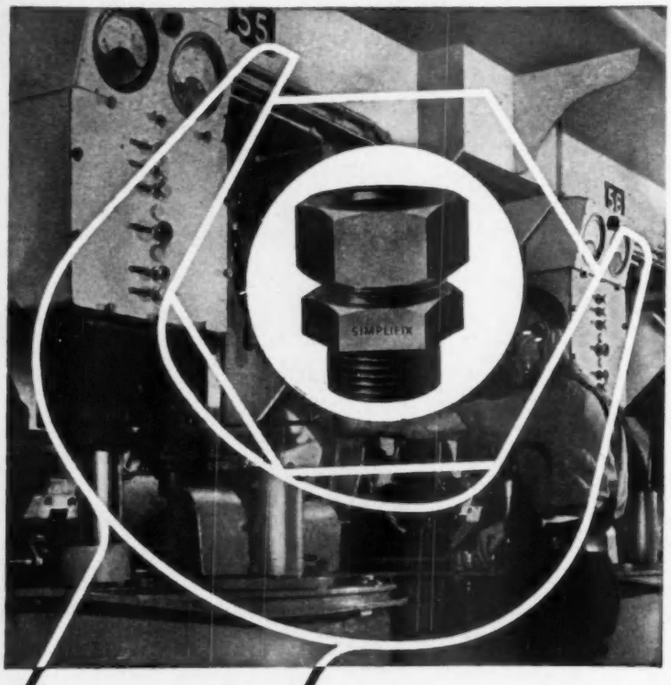

The illustration shows centrifugal machines at the Plaistow Wharf Sugar Refinery of Tate and Lyle Ltd., where large numbers of Simplifix couplings are used.

Simplifix—the sure and simple compression coupling for copper pipe. Perfect joints with almost all kinds of tubing, including those with very thin walls. No work to do on the pipe. Simply tighten the nut—the anti-friction washer prevents pipe twisting. Manufactured since 1930, still the best. Millions in use. Made in sizes to suit tubing from 1/8" to 2" O.D., in a wide range of interchangeable standard fittings. Non-standard fittings also made to order. Let us send you the Simplifix catalogue.

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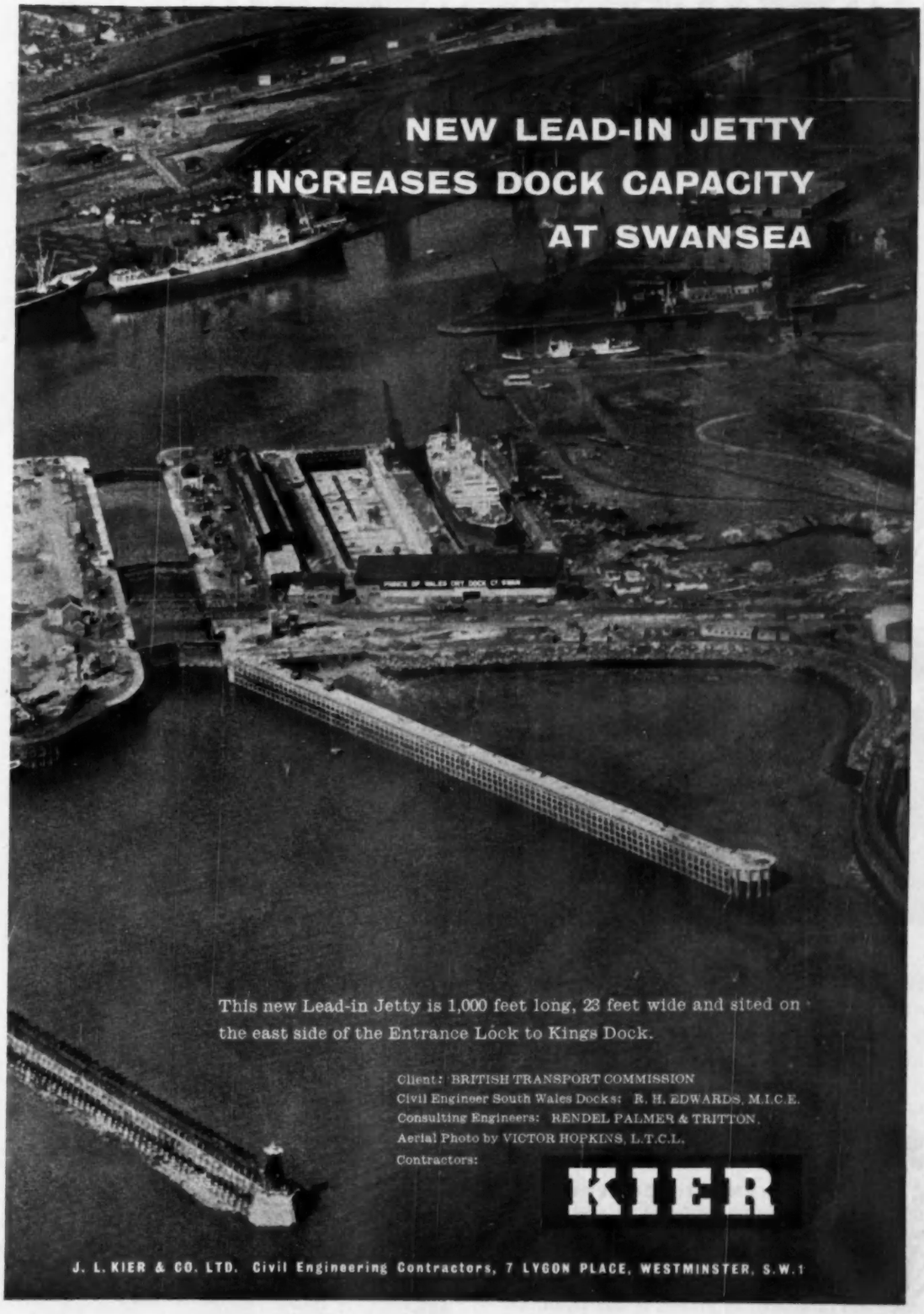
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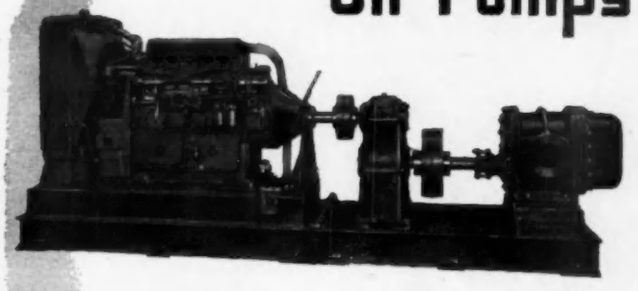

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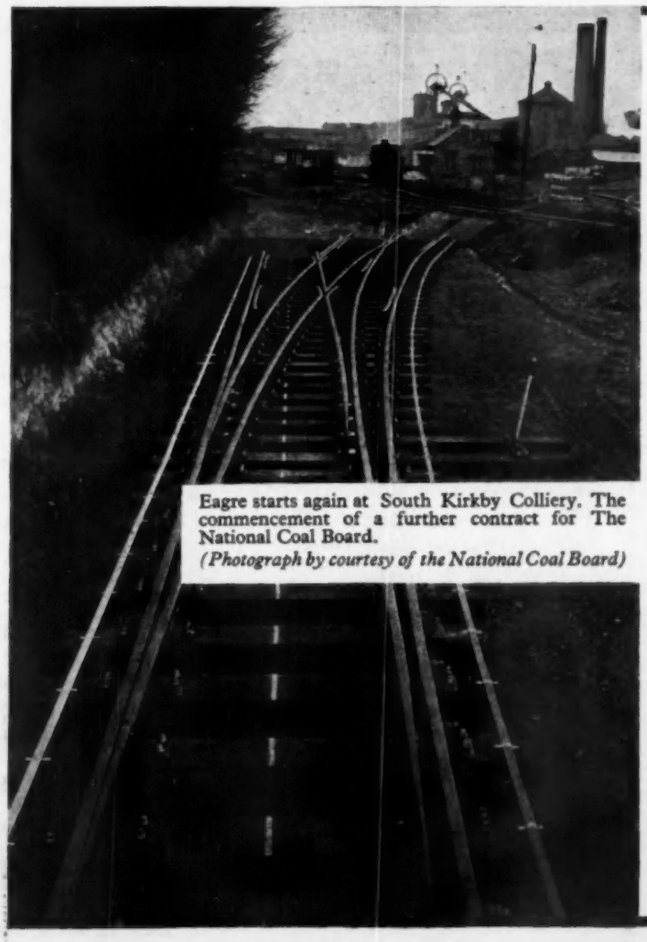

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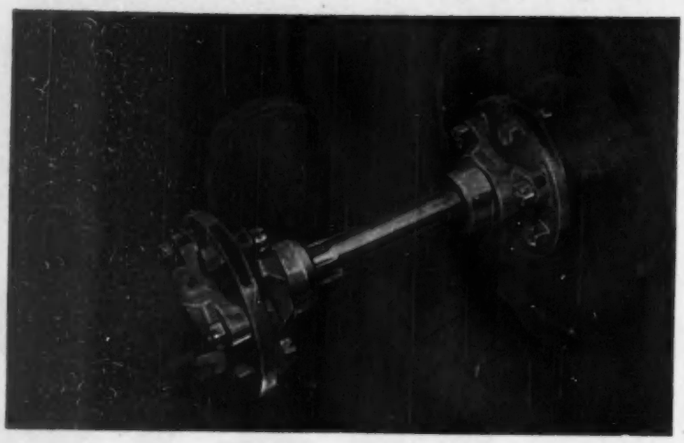

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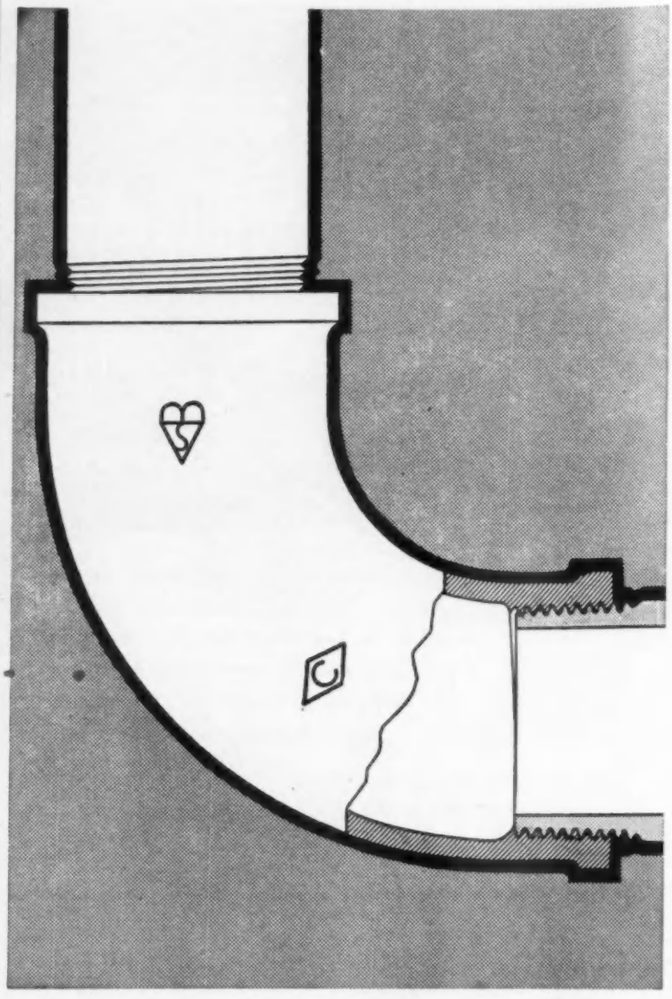

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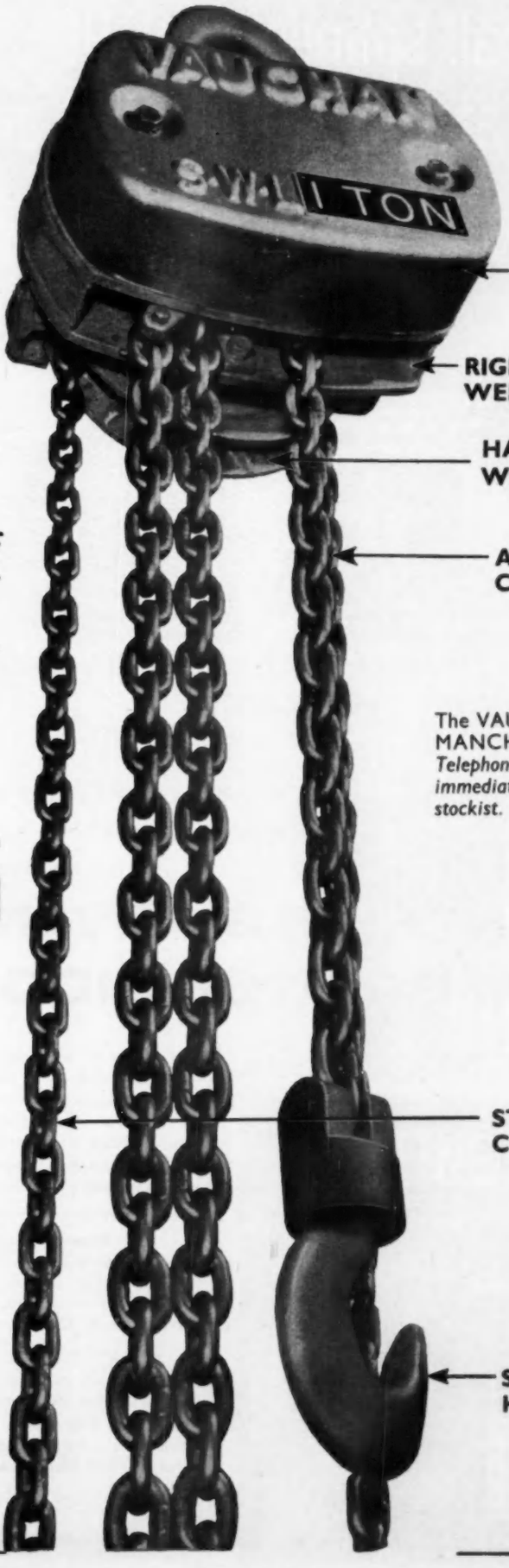

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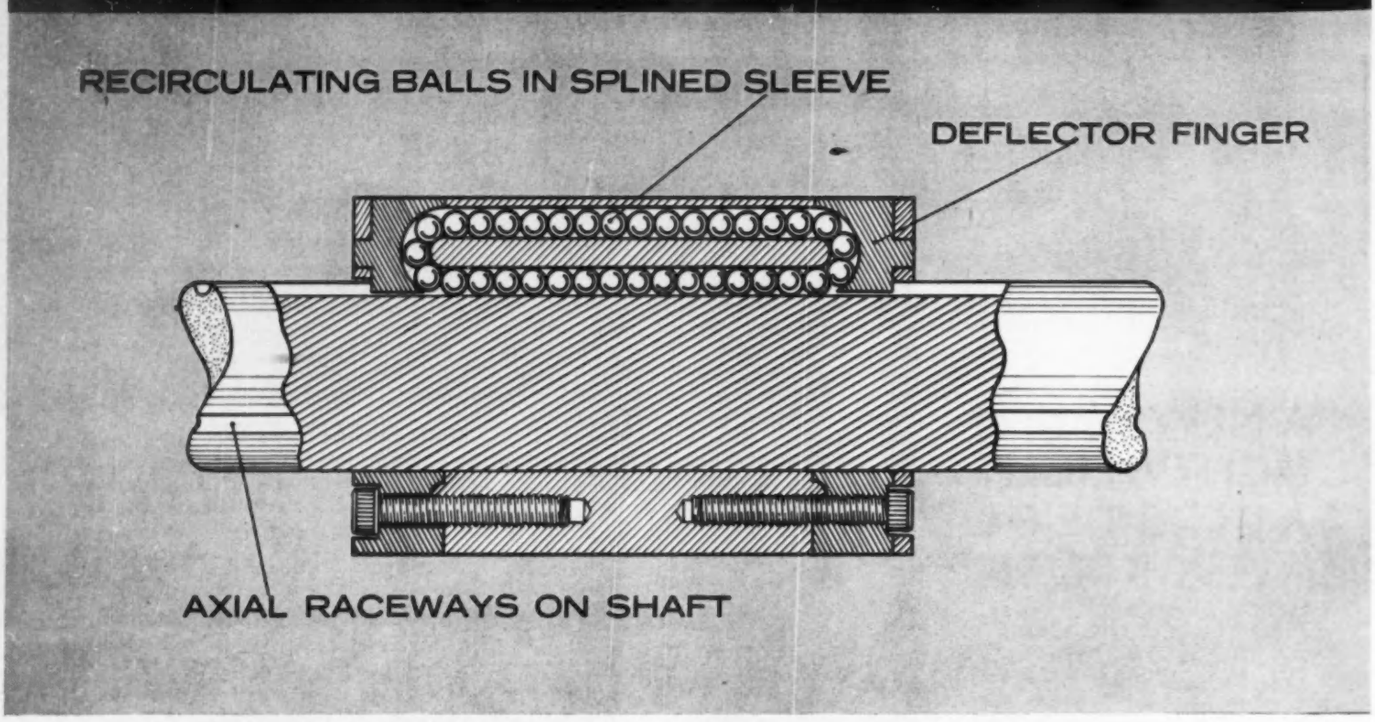

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NEW nut-locking principle

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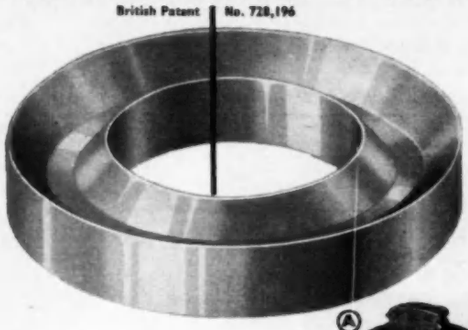
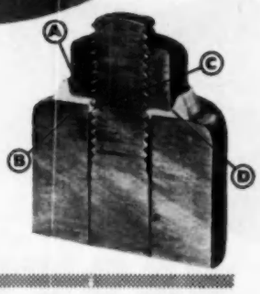
British Patent No. 728,196





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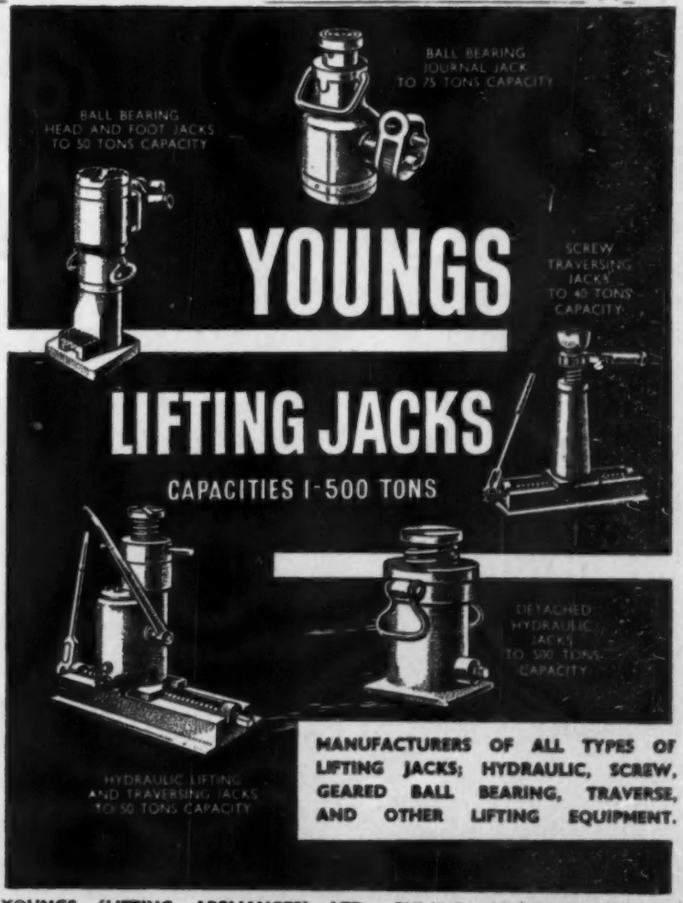
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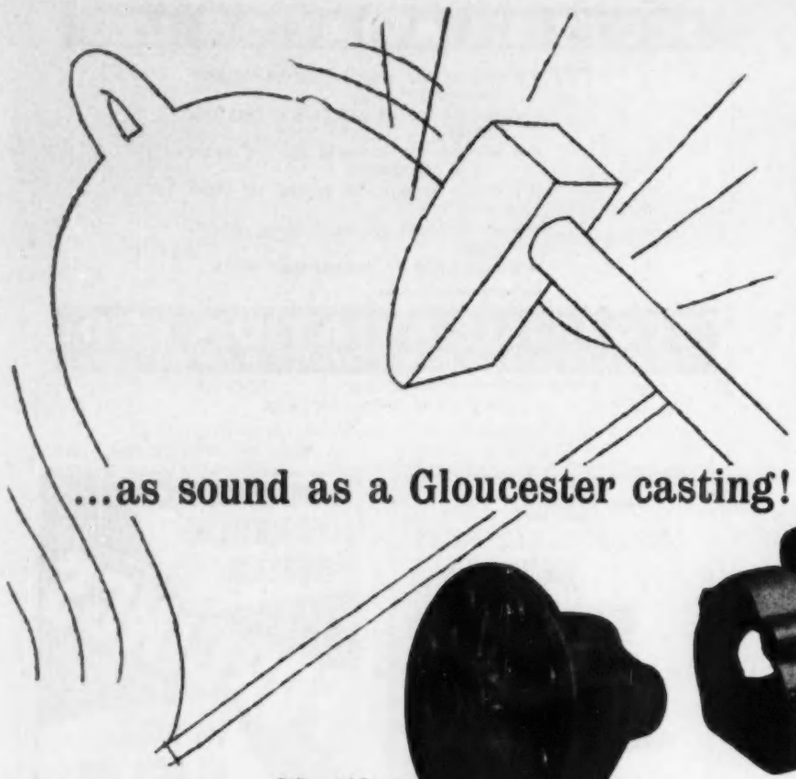

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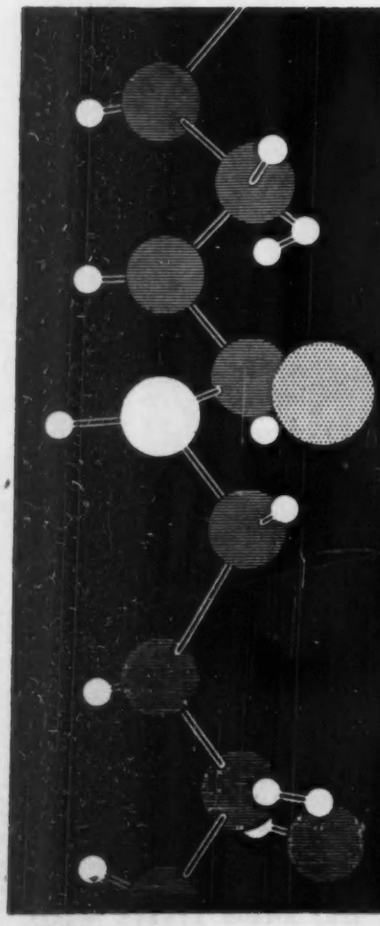

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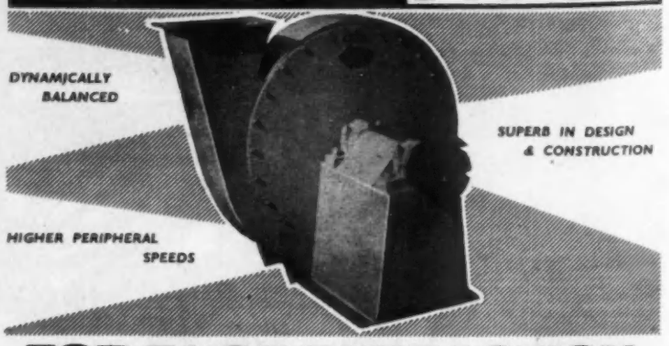

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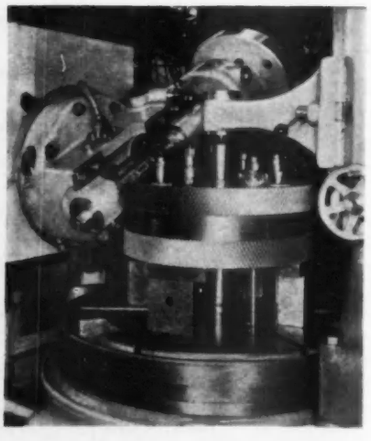

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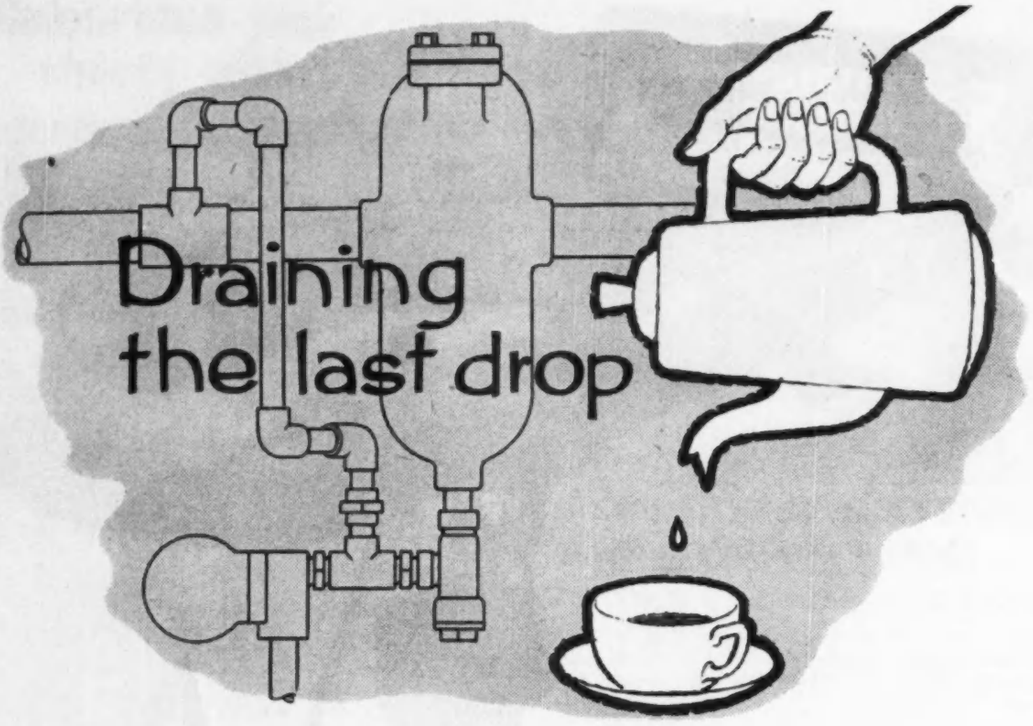

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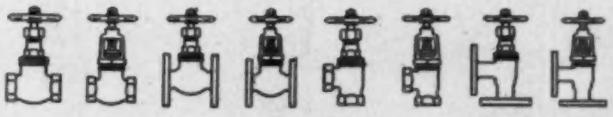

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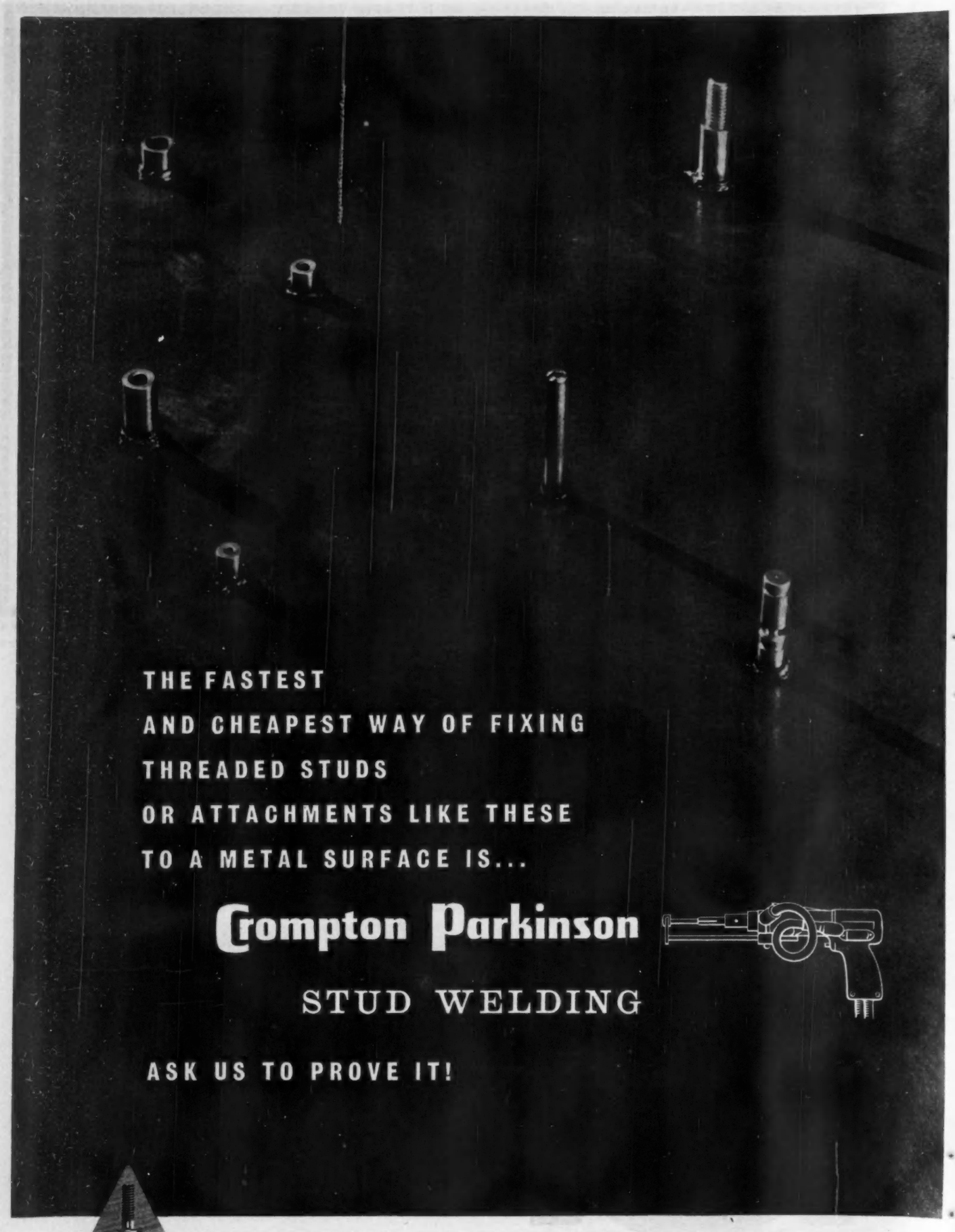
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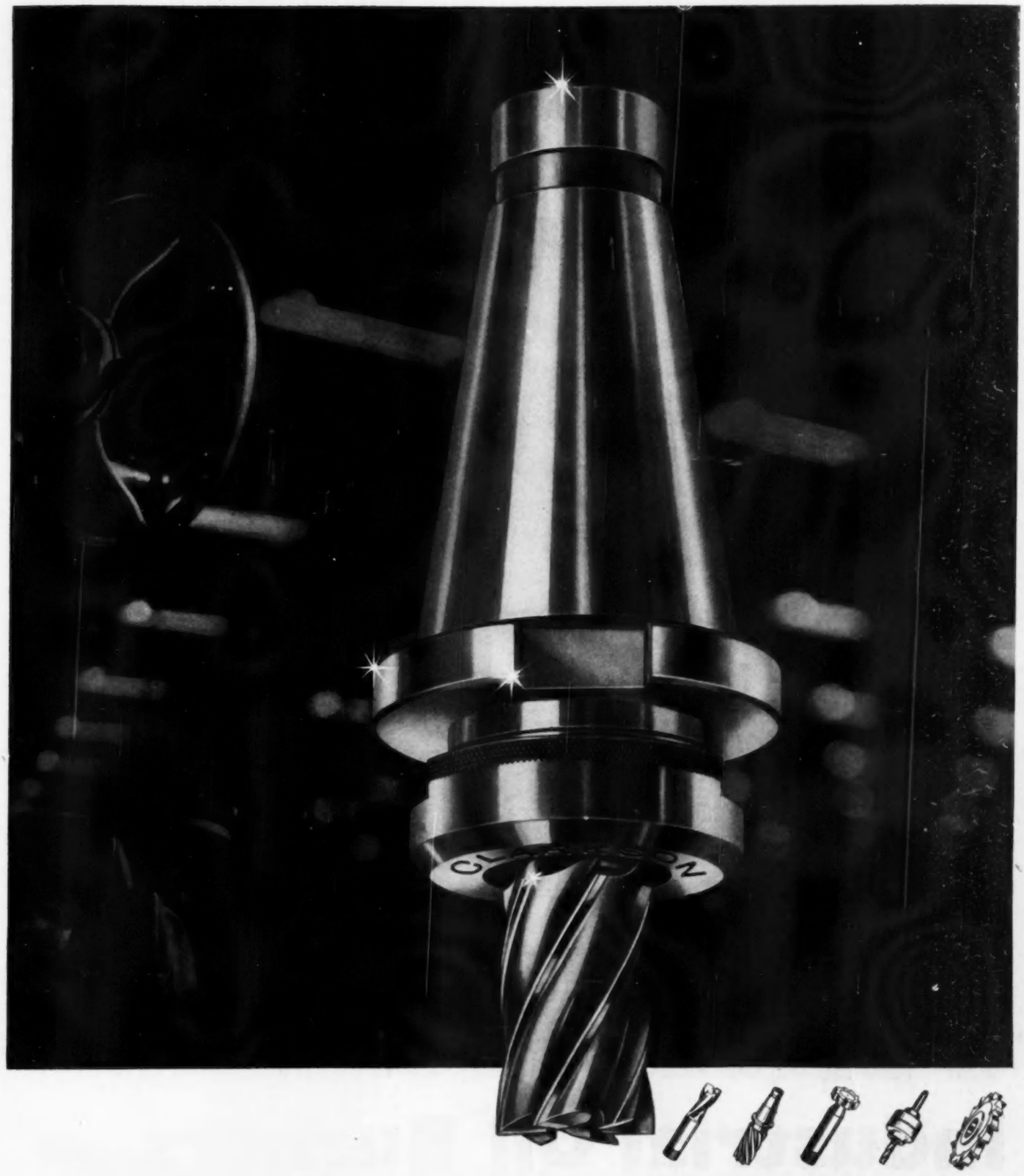

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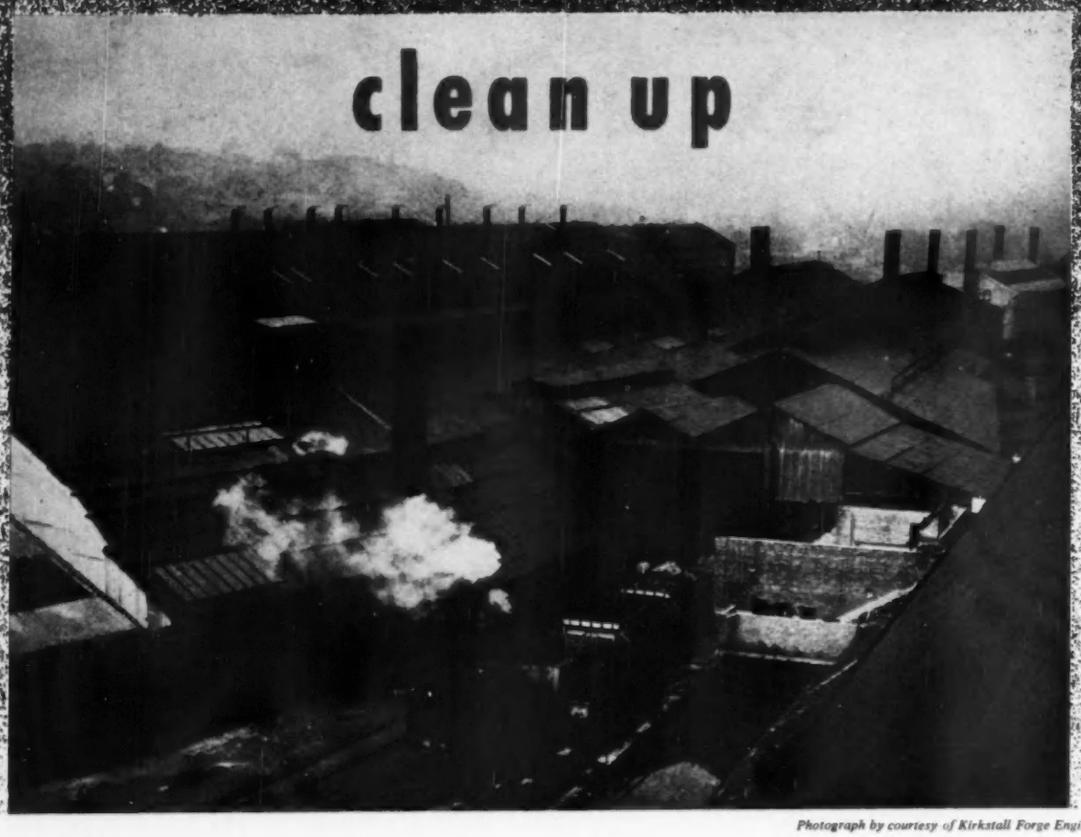

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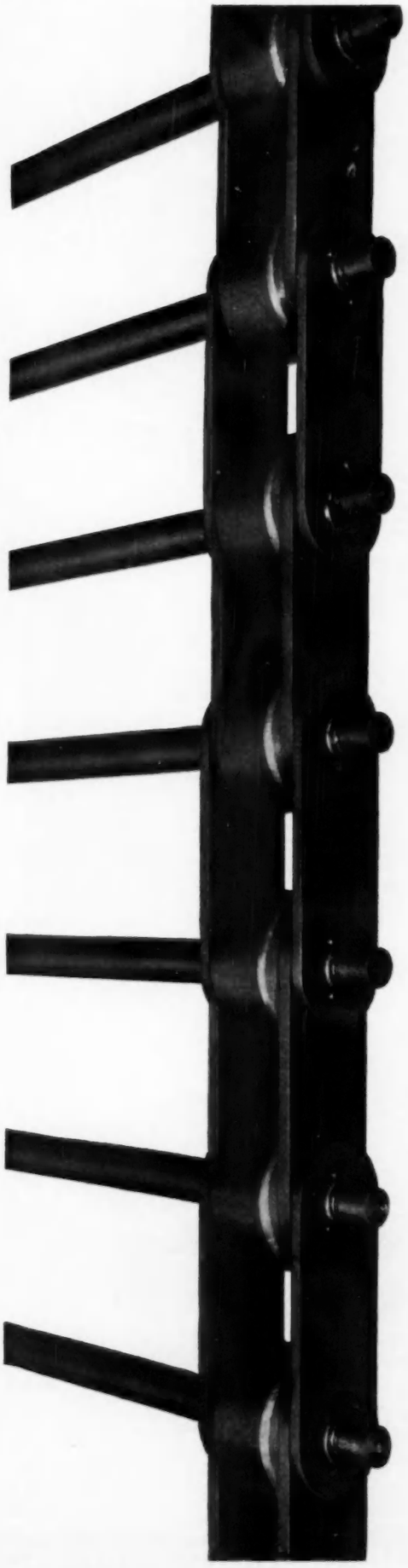

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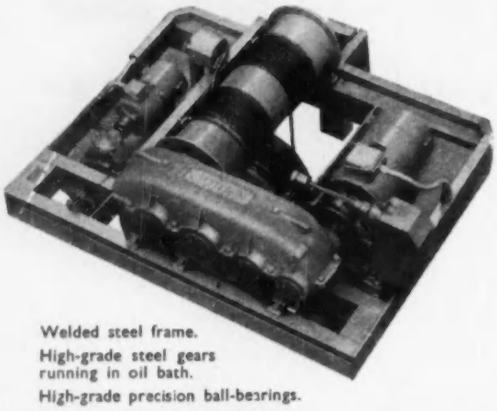

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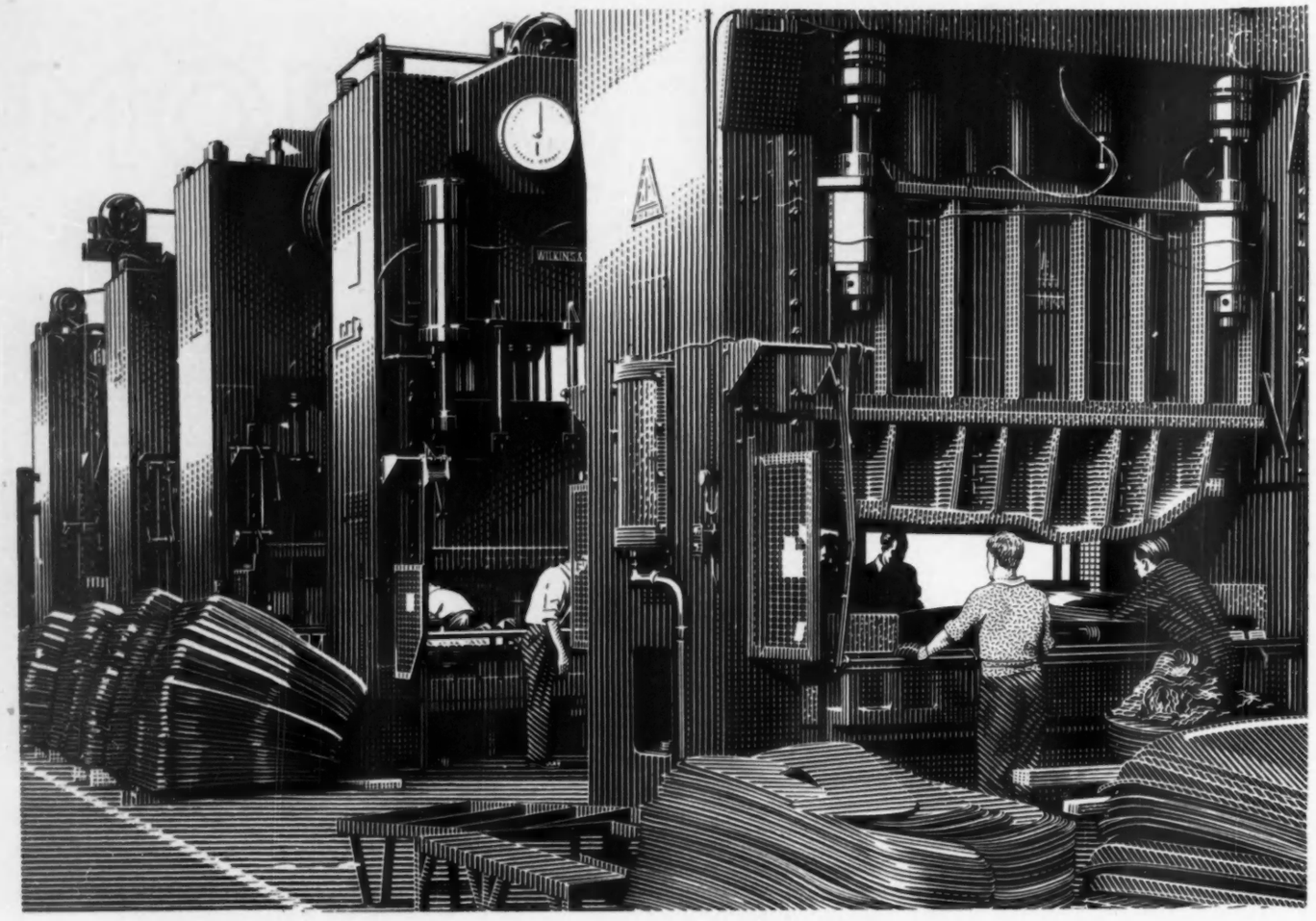

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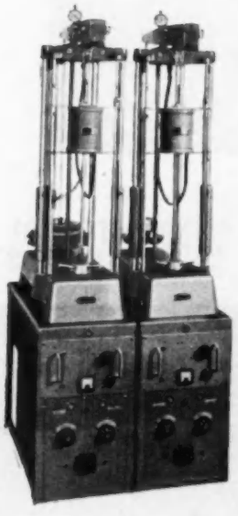

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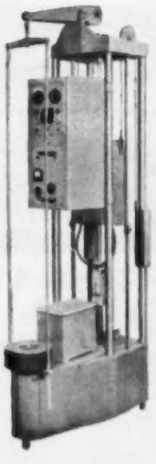
Capacities 5 tons and 15 tons



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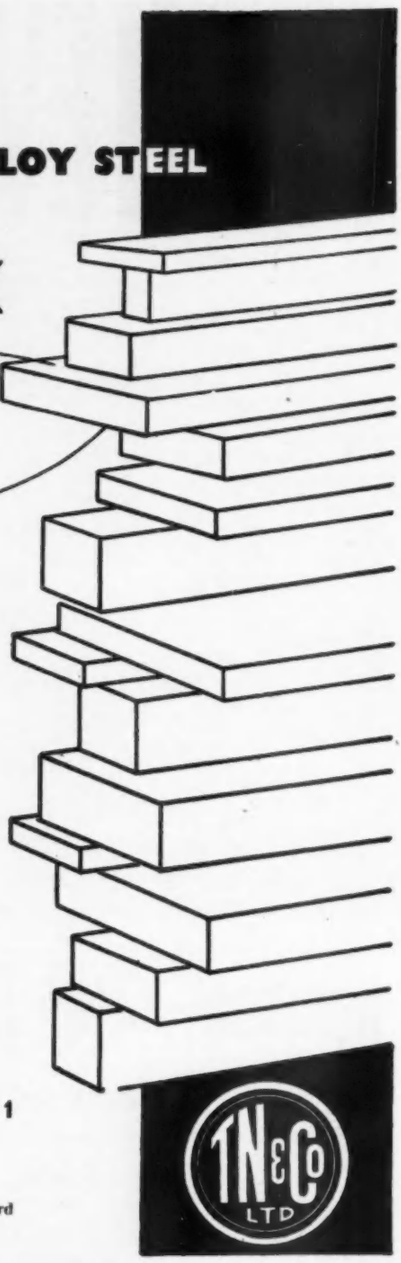

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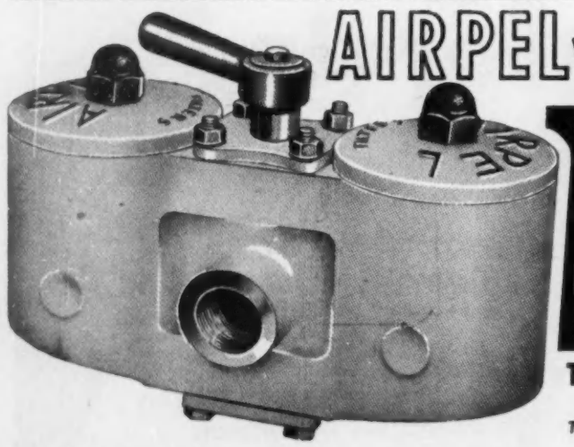

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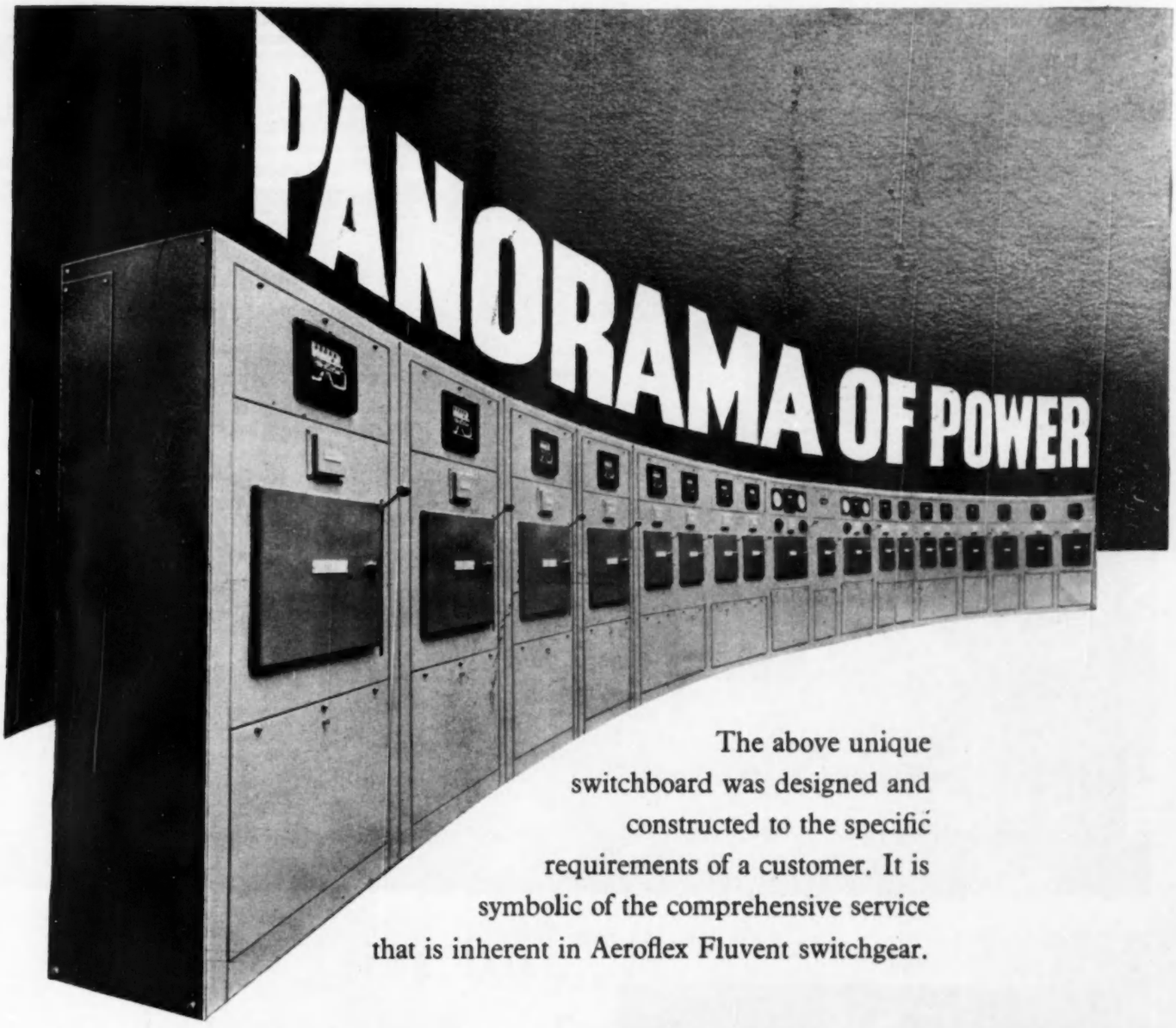

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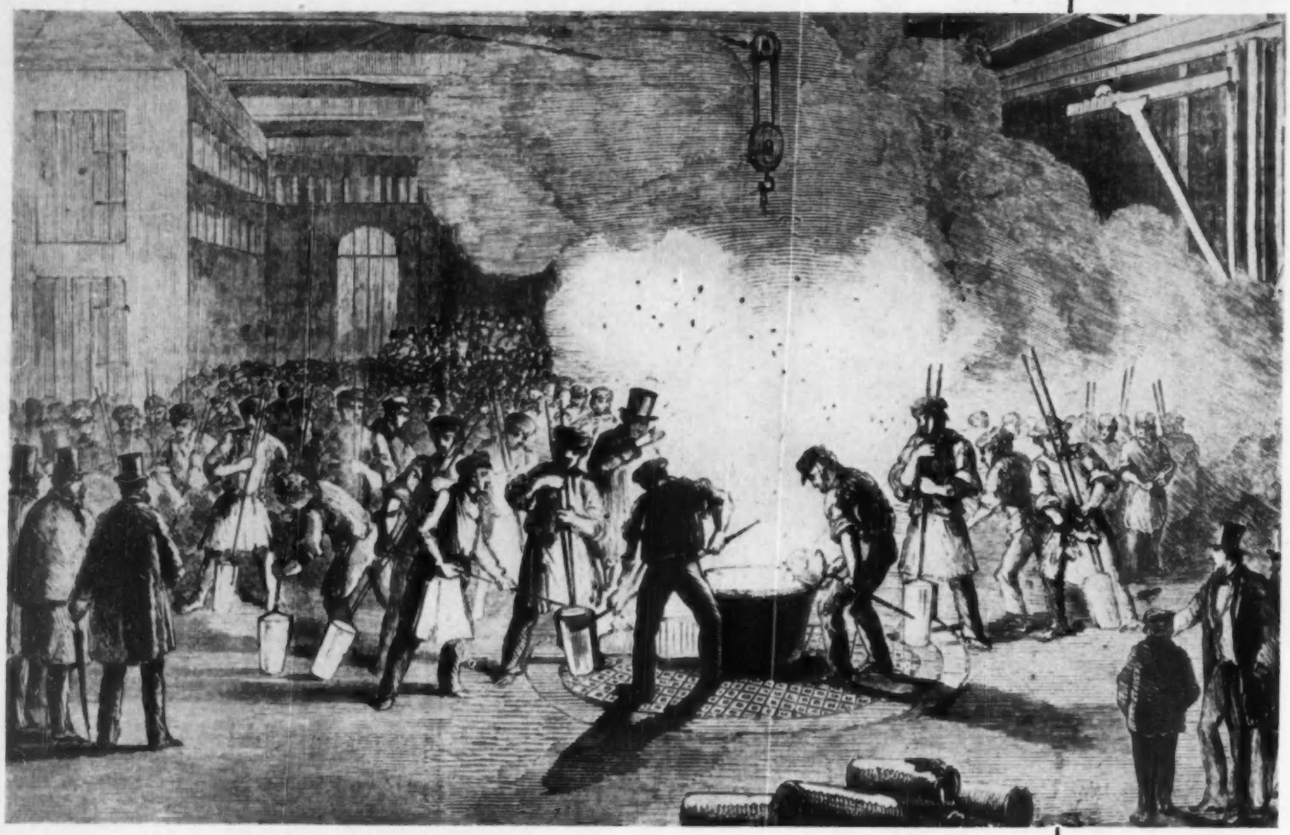

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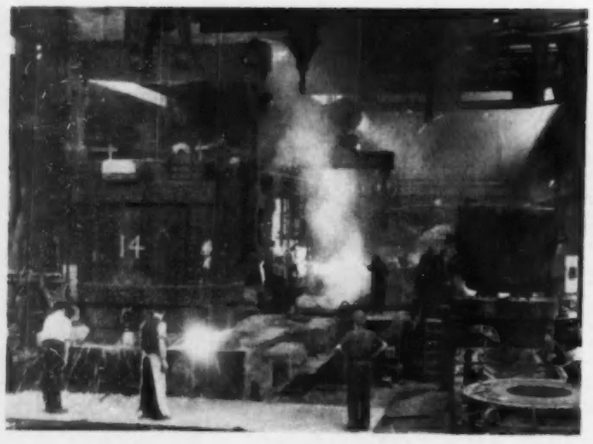

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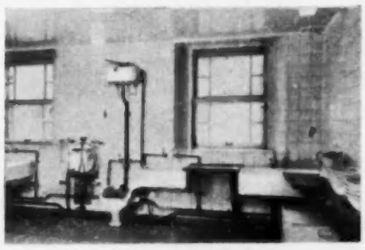

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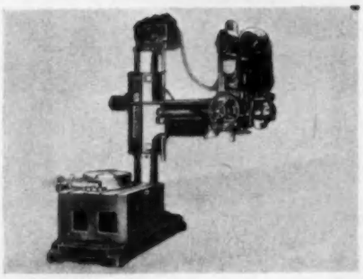

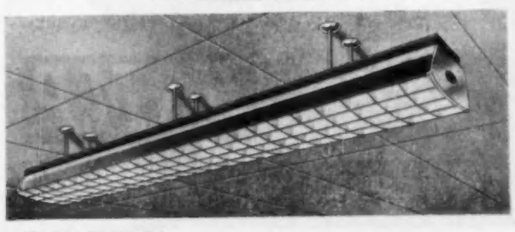

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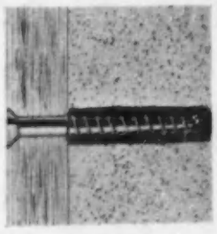

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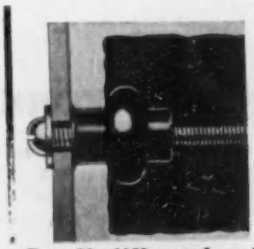

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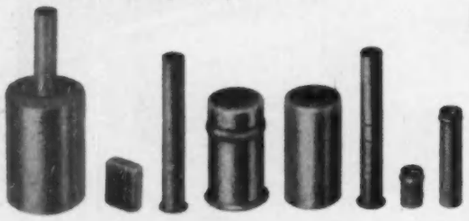

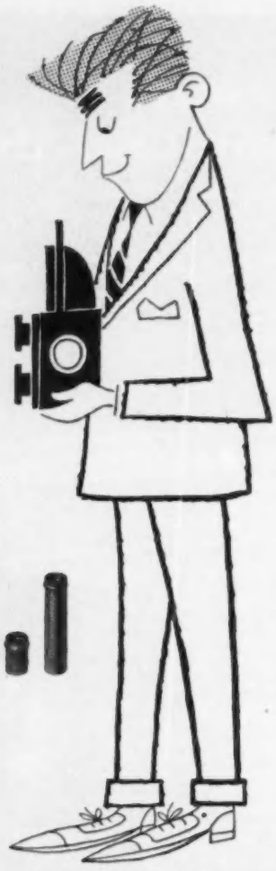

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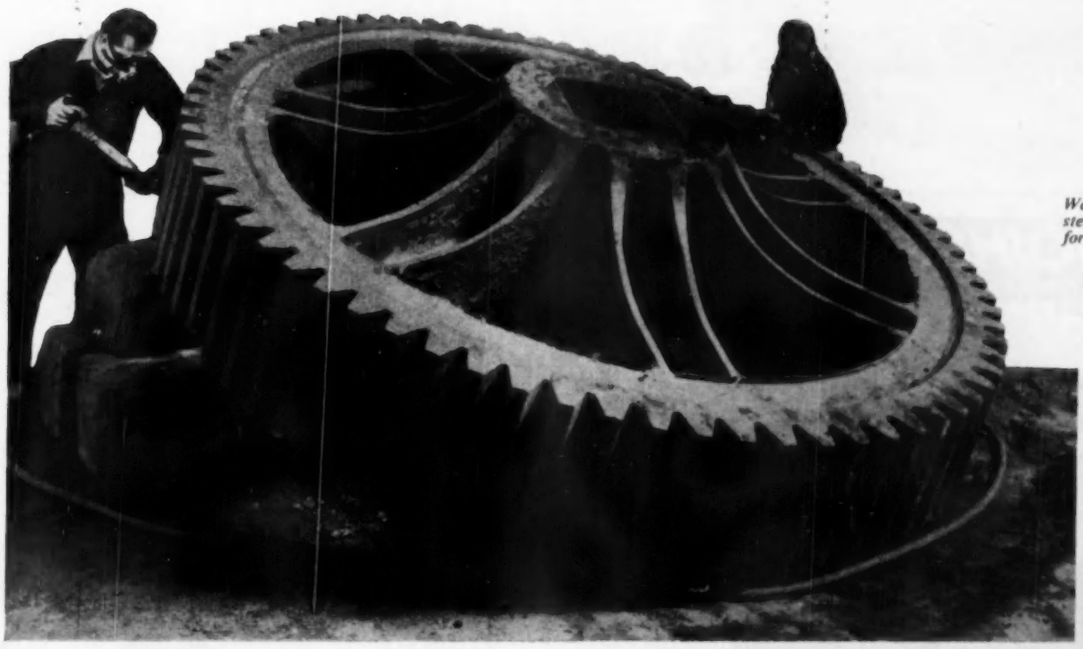

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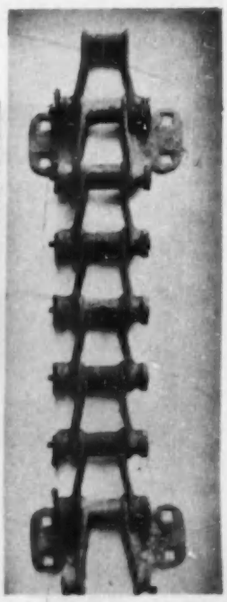

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drop of water

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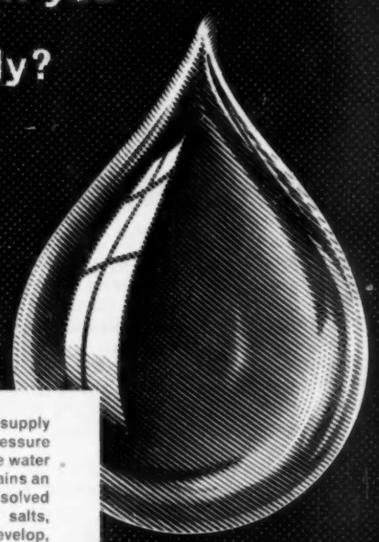

A boiler is designed to supply pure steam at a given pressure and temperature. But if the water used for the purpose contains an excessive amount of undissolved solids, harmful gases or salts, serious trouble may develop, and everything be up with the boiler. The results—delayed production, extra costs and loss of profits could be disastrous.

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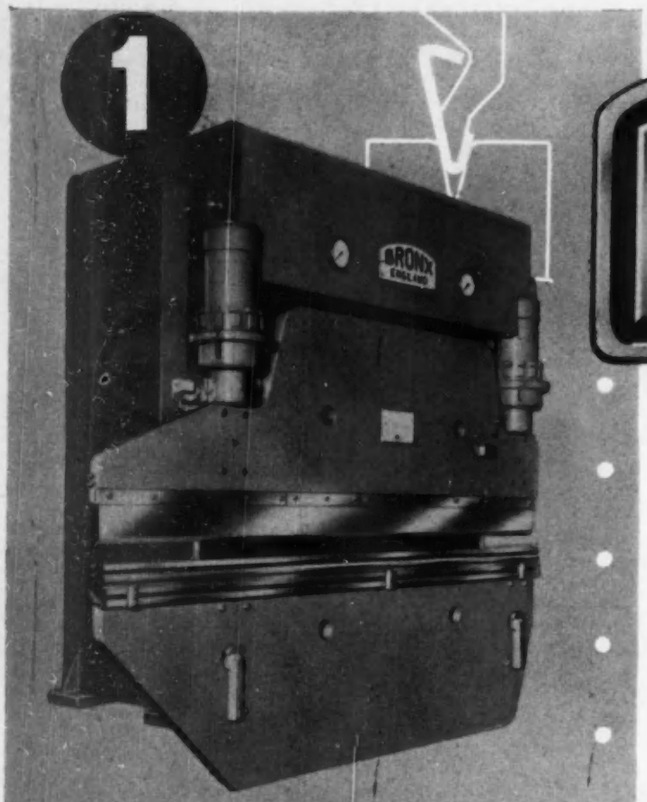

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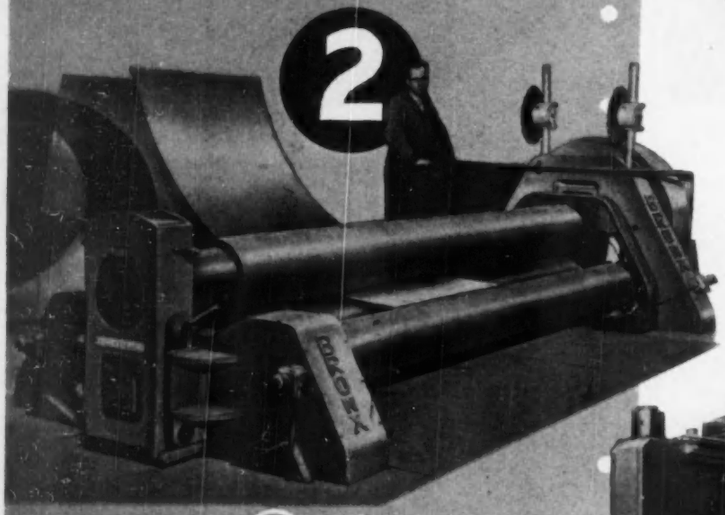

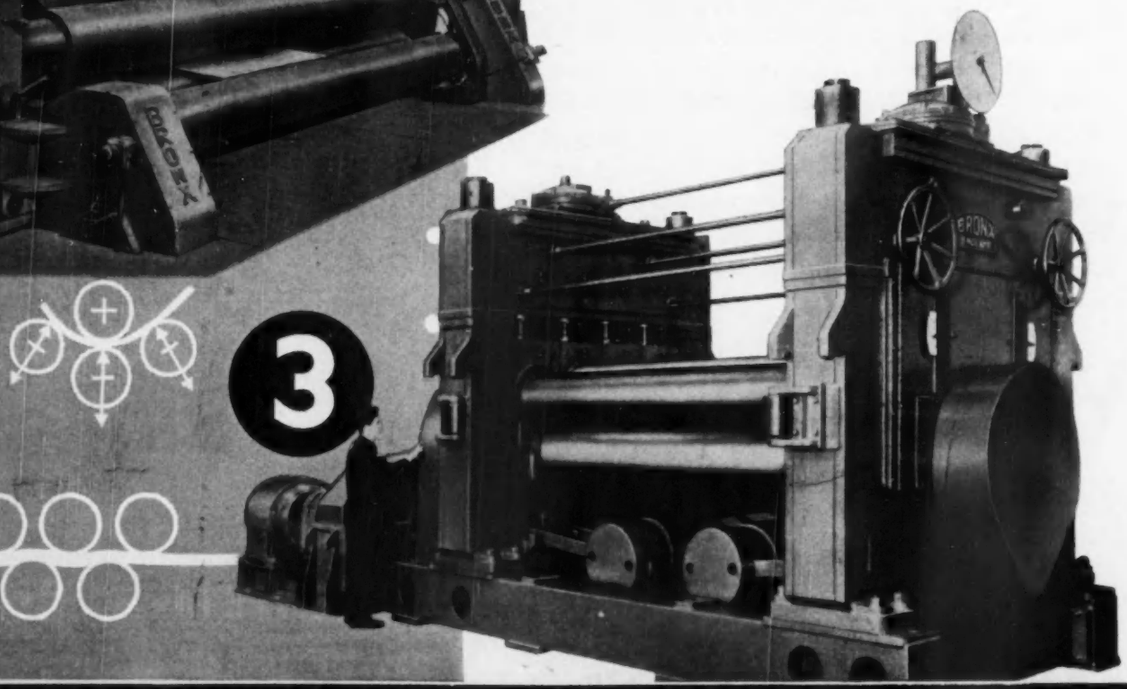

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for CATHODIC PROTECTION

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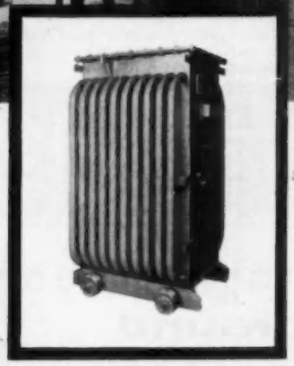

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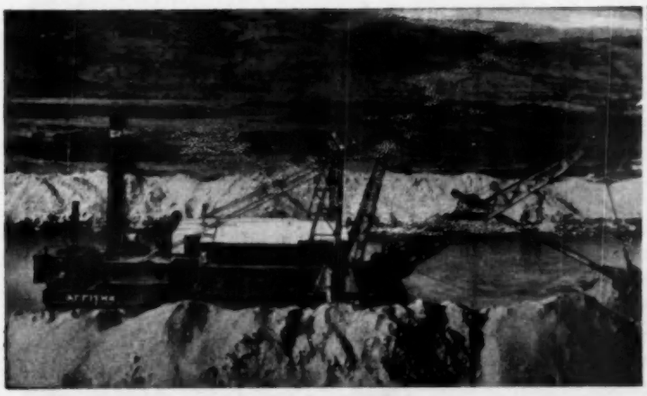

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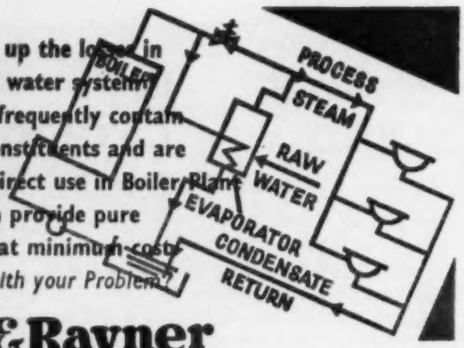

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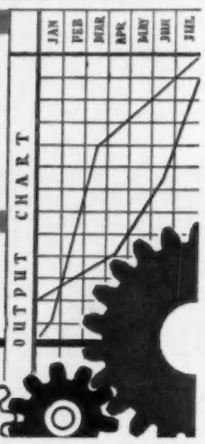

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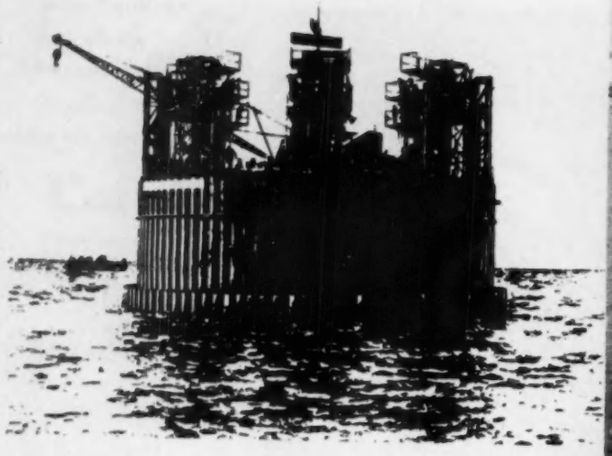
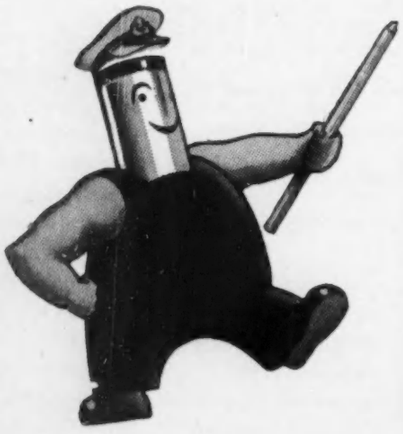


The water intake at this atomic station now being constructed for the Cen. Elec. Generating Board, was built by Taylor Woodrow Construction Co. Ltd., who in association with the English Electric and Babcock and Wilcox Companies are responsible for the design and construction of "Hinkley Point." C. S. Allot & Son are the consultants.

HINKLEY POINT

intake cassion



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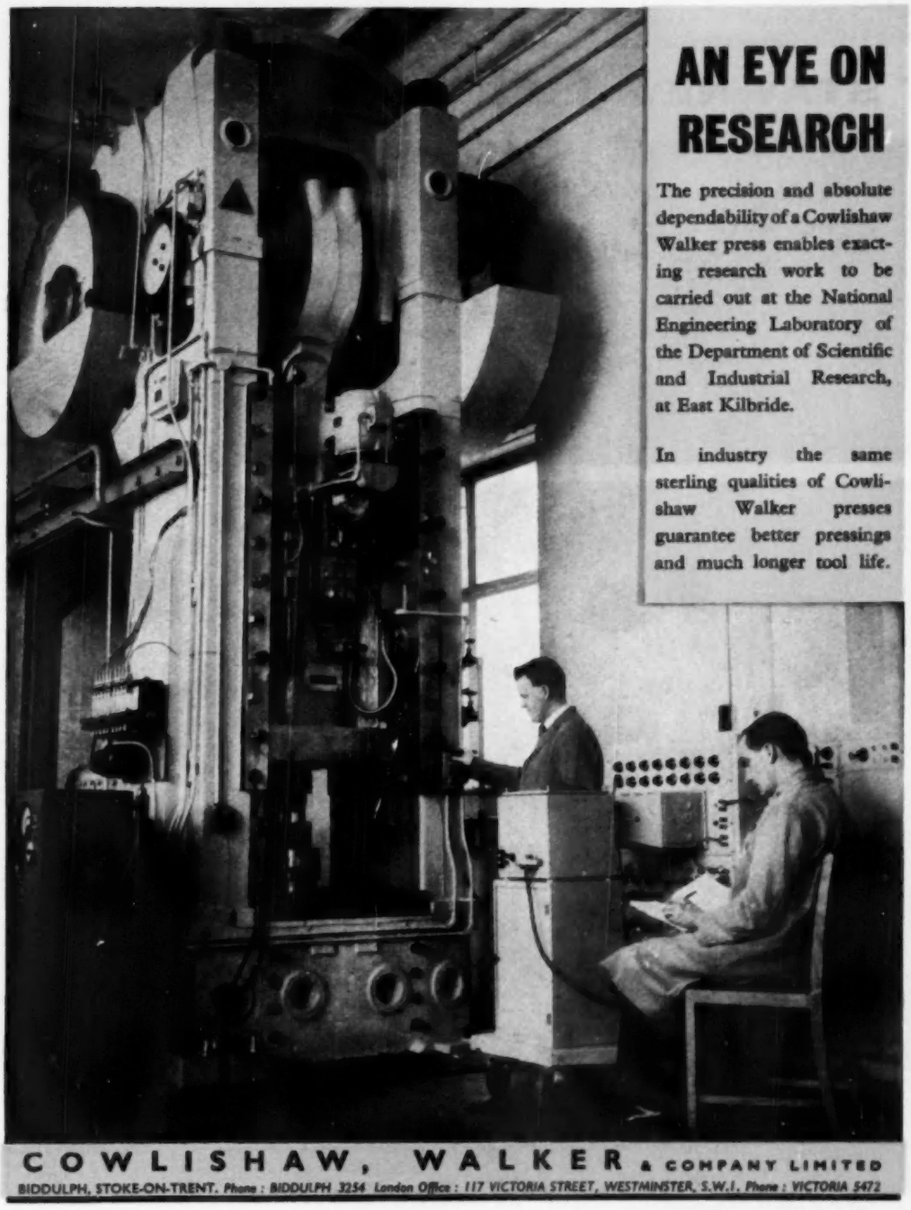

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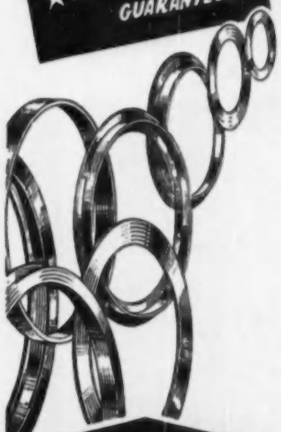

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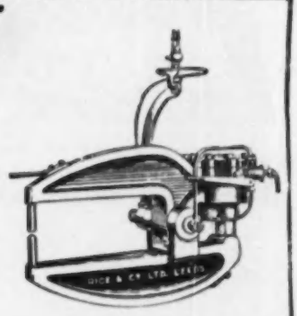

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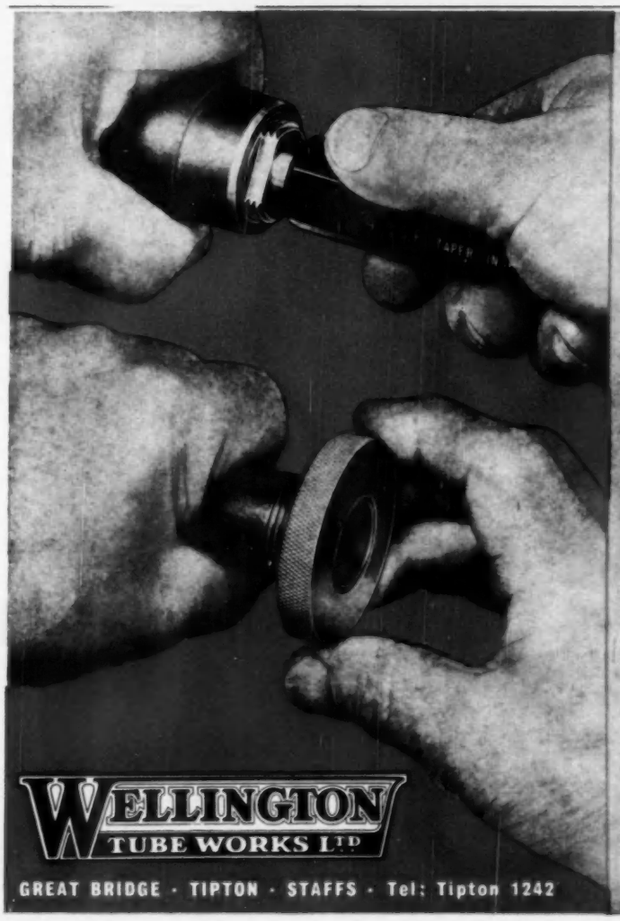

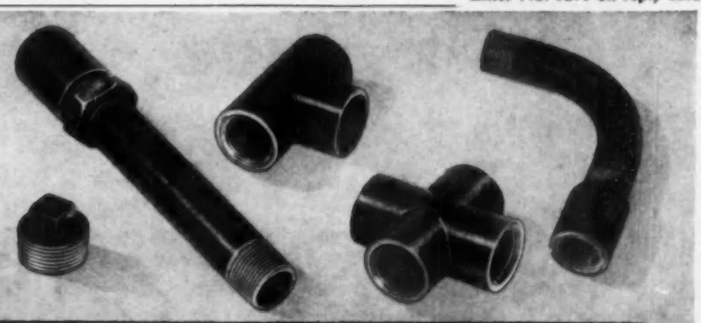

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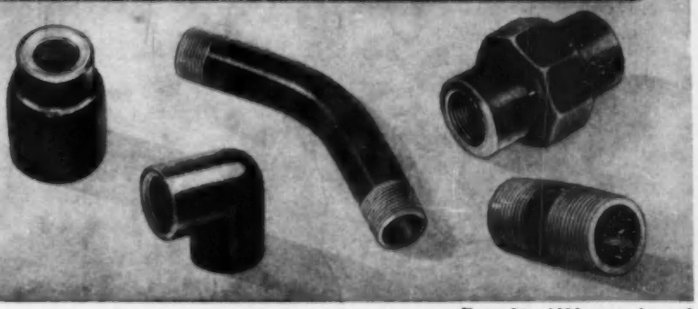

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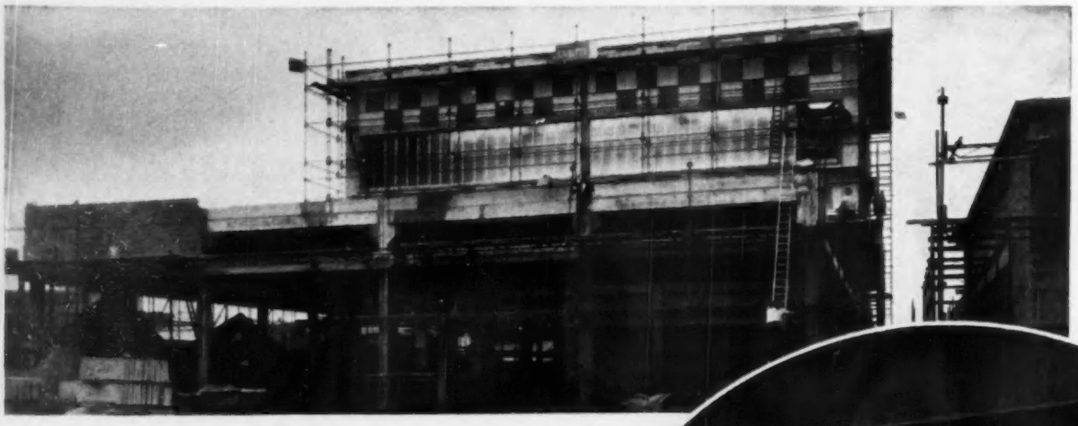

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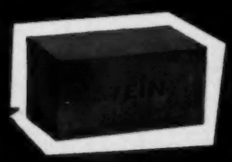

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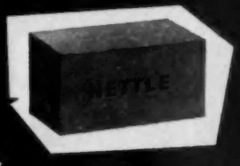

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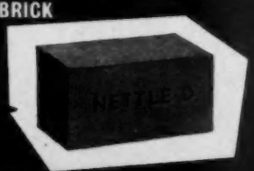

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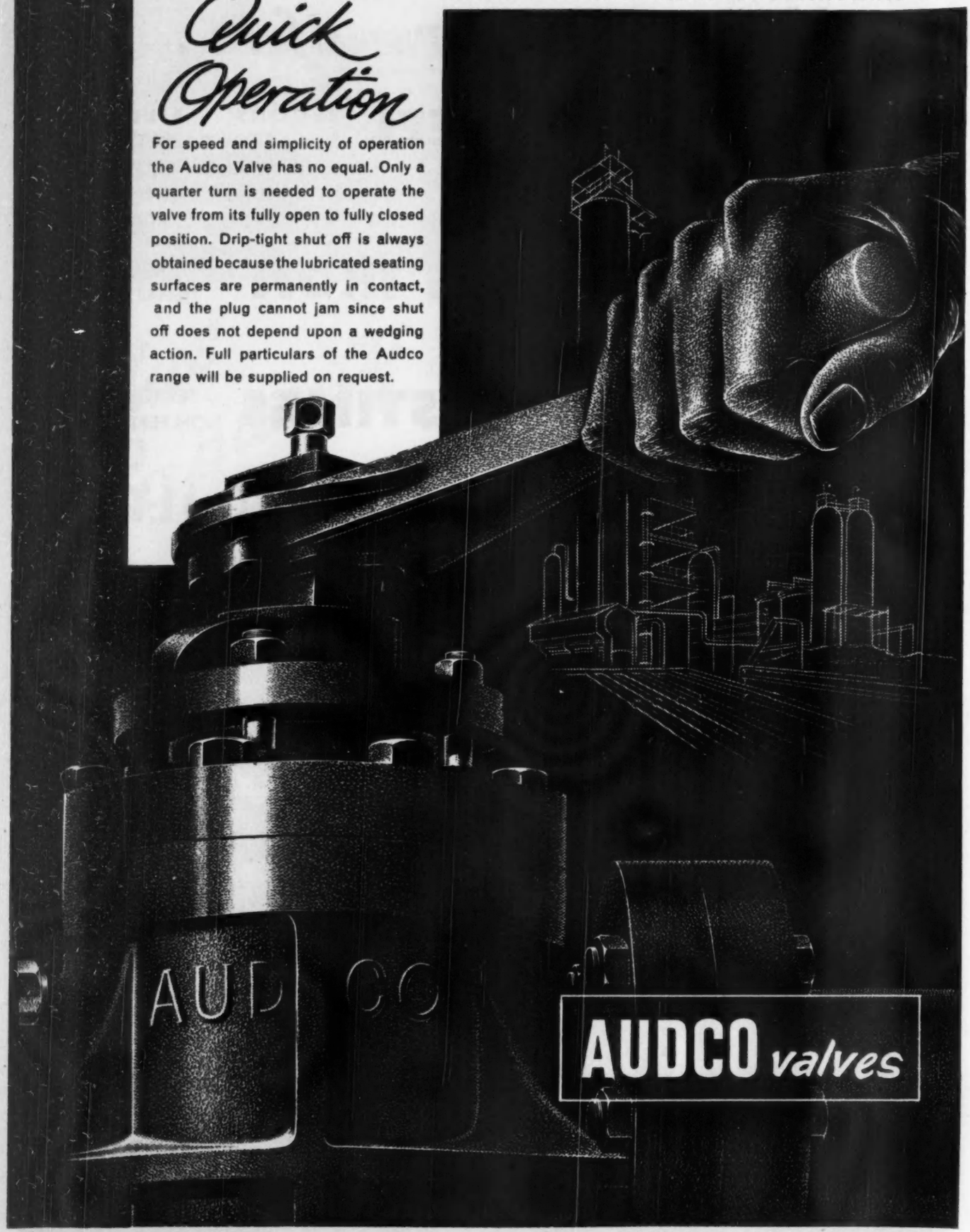

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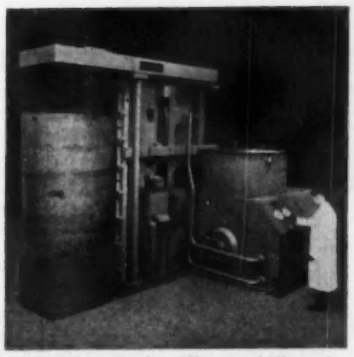

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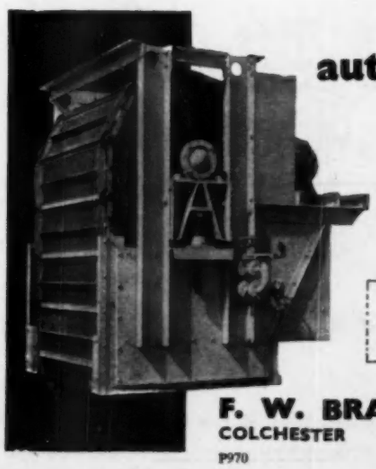
Clapham Street, Leamington Spa, WARWICKSHIRE
Telephone Spa 81112

Enter No. 1313 on reply card



automatic screens

FOR CONDENSER COOLING
WATER-POWER STATIONS
WATERWORKS · FACTORIES
PAPERMILLS & TANNERIES

PUMPS FOR AIR WATER & VACUUM

F. W. BRACKETT & CO. LTD.
COLCHESTER Telephone: 3958
P970

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You immediately limit loss by fire

AND CAN TEST REGULARLY

Install the NATIONAL Quick Release Fitting and you immediately limit the amount of damage a fire can do. When fire breaks out, the NATIONAL Q.R.F. shuts off the fire valve in the oil supply pipe *instantly and independently*. What's more, you can test the fire valve regularly. The NATIONAL Q.R.F. is designed for use with oil-firing equipment, dampers, firescreens, etc., and can be adapted for factories where remote control is required. Full details will be sent to you on receipt of the coupon. Get your secretary to mail it today.

Sales Department, THE NATIONAL BOILER & GENERAL INSURANCE COMPANY LIMITED, St. Mary's Parsonage, Manchester 3.
Please send me full details of the NATIONAL *Quick Release Fitting.*
Name.....
Address.....
.....County.....
.....(Q.R.F.3)

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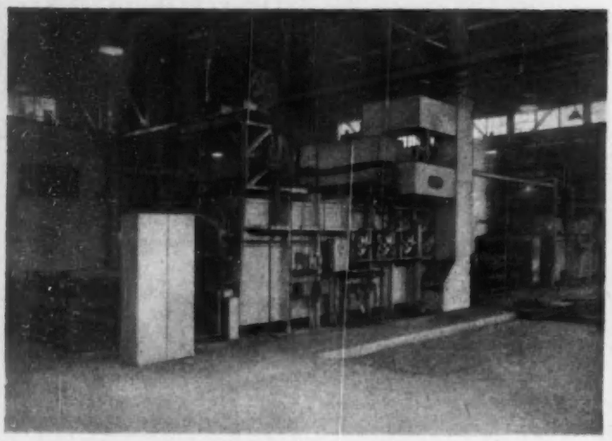
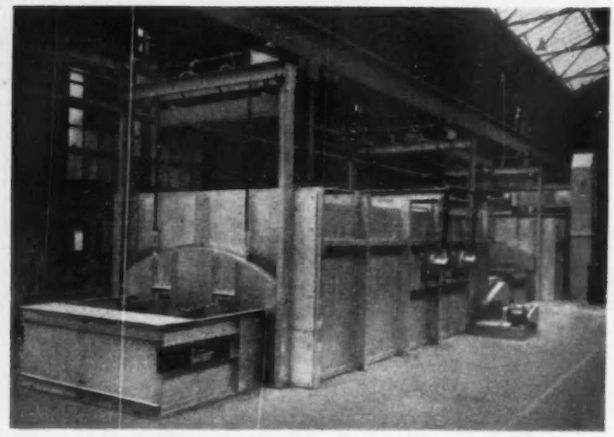
DAVID ETCHELLS FURNACES

For ACCURATE TEMPERATURE AND ATMOSPHERE CONTROL COMBINED WITH MAXIMUM THERMAL EFFICIENCY



AUTOMATIC CYCLE PUSHER HARDENING AND TEMPERING FURNACES
Courtesy of Forgings & Presswork, Ltd.

- We design and manufacture High Intensity Burners, Forges, Galvanizing and Heat Treatment Furnaces, Drying Ovens, etc. Our Technical Staff are available to advise on all applications.



CHAIN CONVEYOR HARDENING AND TEMPERING FURNACES
Courtesy of Rubery-Owen, Ltd.

DAVID ETCHELLS (FURNACES) LTD. STAFFORD ROAD, DARLASTON, S. STAFFS

TELEPHONE: JAMES BRIDGE 2067/8 & 2273/5

FURNACE ETCHELLS ENGINEERS

Enter No. 1321 on reply card

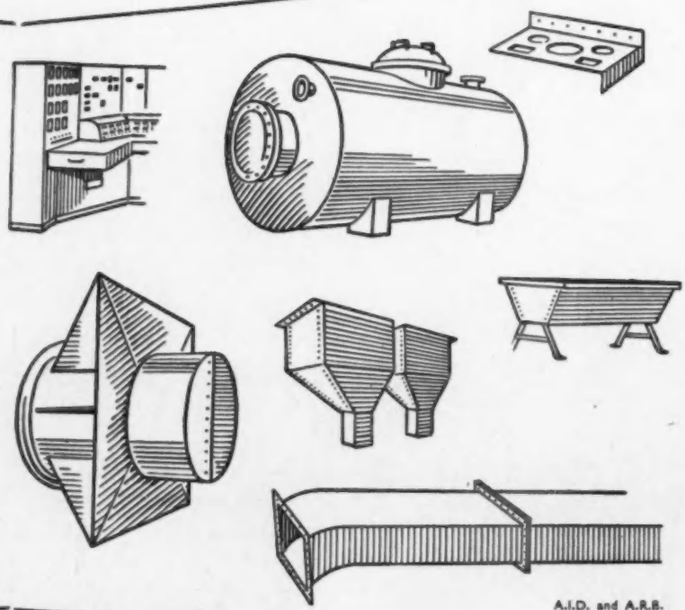
EVERYTHING IN SHEET METAL WORK GENERAL ENGINEERING

Consult

V. W. CO., LTD.

FOR FABRICATION and GENERAL ENGINEERING

General Sheet Metal Work, Metal Pressing and Stamping, Duct Work and Ventilating Plants, Tanks Cylinders Turning, Milling etc. PLATING, Chrome, Nickel, Cadmium etc.



A.I.D. and A.R.B. approved

V. W. CO., LTD.

Radspray Works, High Street, Stratford, London, E.15 *Tel: MARyland 6761 (6 lines)*

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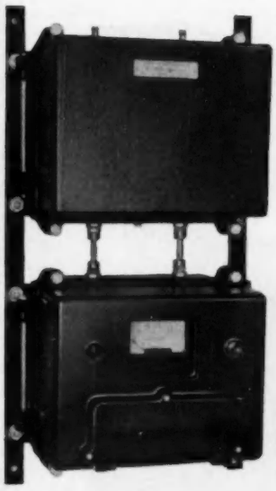
a new approach to oxygen analyser design

GIVES FASTER RESPONSE, SAFER AND EASIER OPERATION, GREATER RELIABILITY AND ACCURACY, WIDE RANGE–FLEXIBILITY EXTREME RUGGEDNESS–



An all-British analyser designed specifically for arduous chemical plant service. Faraday's direct method for measuring magnetic susceptibility has been modernised to give a rapid and specific measurement free from the technical snags of the magnetic wind principle. The delicate suspension is replaced by rare metal, providing a virtually unbreakable measuring system. The analyser is ideal for boiler control and chemical process use.

- *F.S.D. 1% to 100% in six ranges*
- *Rapid response—95% response to input step change achieved in 8 seconds with maximum sample flow-rate.*
- *Metal dumb-bell suspension proved against shocks of 2,000 g*
- *Unaffected by viscosity, thermal conductivity and density, and insensitive to tilting and changes in sample flow-rate.*
- *Proved by years of plant use.*

Full details and technical advice from
SERVOMEX CONTROLS LIMITED
(Chemical Instruments Division)
Crowborough Sussex Crowborough 1247

DCL **SERVOMEX** Oxygen Analyser type 83

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MAGNETIC AID FOR EVERY TRADE

LIFTING MAGNETS
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TELEPHONE CENTRAL 5391
TELEGRAMS BOXMAG B'HAM

ELECTROMAGNETS LTD.
Boxmag Works, Bond St., Birmingham, 19. England

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Steel and Spheroidal Graphite Iron

CASTINGS

also **HIGH QUALITY ENGINEERING**
and MACHINE TOOL GREY IRON
CASTINGS UP TO 10 TONS

R. GOODWIN & SONS (ENGINEERS) LTD.
Ivy House Foundry · Hanley · Stoke-on-Trent
Staffs. *Tel.:* Stoke-on-Trent 23612

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ACID RECOVERY OR DISPOSAL

THE COMPLETE SOLUTION

SULPHURIC ACID On high speed strip lines the new Kestner Recovery Plant offers maximum economy—freedom from fumes and low maintenance—low capital cost.

HYDROCHLORIC ACID On batch or continuous processes—a new process developed and used on the Continent—no by-product—good economy—no fumes.

SULPHURIC ACID On batch processes with limited output the well proven Kestner-Fakler process still offers the least expensive answer.

SULPHURIC ACID On non-ferrous plants the standard Kestner Recovery Unit regenerates acid and recovers copper—no discharge of effluent—low maintenance and running costs—easily marketable by-product of electrolytic copper.

MIXED ACIDS Where acid recovery cannot be applied Kestner offer a complete range of neutralising plant employing various standard units.

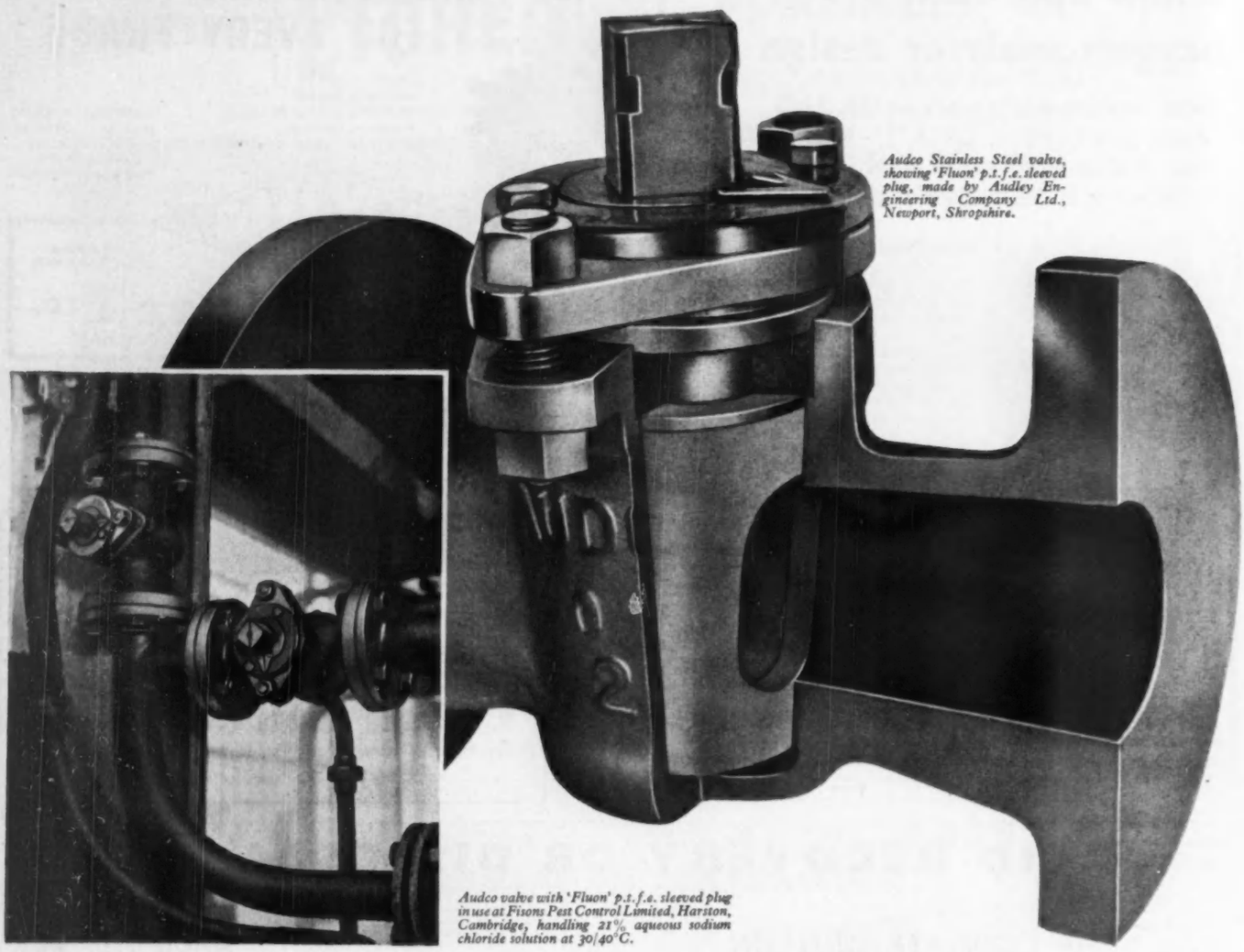
May we give you further information

KESTNER EVAPORATOR & ENGINEERING CO. LTD.
5 GROSVENOR GARDENS, LONDON, S.W.1

Kestner
THE CHEMICAL ENGINEERS

Enter No. 1334 on reply card

'FLUON' INCREASES PRODUCTION EFFICIENCY IN INDUSTRY



Audco Stainless Steel valve, showing 'Fluon' p.t.f.e. sleeved plug, made by Audley Engineering Company Ltd., Newport, Shropshire.

Audco valve with 'Fluon' p.t.f.e. sleeved plug in use at Fisons Pest Control Limited, Harston, Cambridge, handling 21% aqueous sodium chloride solution at 30/40°C.

Valves with 'Fluon' sleeved plugs handle any chemical without sticking or leaking and need no lubrication

THIS VALVE, made by Audley Engineering Company Ltd., can handle virtually any chemical at pressures up to 150 p.s.i. and temperatures up to 100°C. It requires a remarkably low turning effort, won't stick or gall, and never needs lubrication or any other maintenance. Its secret is that its plug has a thin sleeve of 'Fluon' p.t.f.e. compounded with a suitable inert filler for dimensional stability.

This is only one out of hundreds of products that benefit from the remarkable properties of 'Fluon'. 'Fluon' is an I.C.I. plastic material which is immune to virtually all forms of chemical attack. It has a working temperature from +250°C. down to at least liquid nitrogen temperatures, the best dielectric properties and the lowest coefficients of friction of any solid. It is also both tough and flexible.

Audco valves with 'Fluon' p.t.f.e. sleeved plugs in use at Fisons Pest Control Limited, Harston, Cambridge, handling chlorinated solvent containing ½% anhydrous H.Cl. at 95°C.

'FLUON'

'Fluon' is the registered trade mark for polytetrafluoroethylene manufactured by I.C.I.

ICI IMPERIAL CHEMICAL INDUSTRIES LIMITED · LONDON · S.W.1

Enter No. 1341 on reply card

CLASSIFIED ADVERTISEMENTS

PUBLIC APPOINTMENTS · SITUATIONS VACANT · TENDERS · EDUCATIONAL · BUSINESSES and PREMISES · BUSINESS OPPORTUNITIES PATENTS · MISCELLANEOUS · AGENCIES · DIRECTORS · PARTNERSHIPS

Lineage Rate. 4/6 per line of approximately 6 words. Minimum 18/-. **Inch Rate.** 54/- per single column inch and pro rata. 12 lines to 1 inch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £29 10s. ½-page £54. Full page £100.

FOR SALE · MACHINERY, etc., WANTED · AUCTION SALES · SITUATIONS WANTED · SUB-CONTRACTING · DESIGN SERVICES · FOR HIRE

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-. **Inch Rate.** 48/- per single column inch and pro rata. 12 lines to 1 inch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an Illustrated advertisement it is a ¼-page (12 column inches) Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. Tuesday for publication on Friday of the same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

Advertisements for publication should be addressed to:—**Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London, W.C.2**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

CHESHIRE EDUCATION COMMITTEE

CHESHIRE COUNTY TRAINING COLLEGE, ALSAGER, STOKE-ON-TRENT

ONE YEAR COURSE OF TEACHER TRAINING FOR CRAFTSMEN

Cheshire Local Education Authority, with the approval of the Ministry of Education, will provide at the above-named College from September, 1961, a one-year course designed to give skilled Craftsmen teacher training to enable them to take up posts as teachers of Handicrafts in Secondary Schools.

Applications are therefore invited for admission to this course from men who already possess appropriate qualifications, such as a Full Technological Certificate of the City and Guilds of London Institute, or a Higher National Certificate or Higher National Diploma, and who wish to be trained as teachers.

The particular academic requirements of individual students and the application of their craft skills to the needs of schools will be specially studied. The year of training will include periods of teaching in schools.

The basic salary scale for qualified assistant teachers is £520 per annum, rising by annual increments of £27 10s. and one final increment of £40, to a maximum of £1000. Additional increments are given for approved qualifications and training. Account may also be taken of approved industrial experience acquired over the age of 21, up to a maximum of 12 increments.

Anyone needing further advice about the course, the qualifications required, the grants available to students while attending the course, and the teaching prospects available at the end of the course, should communicate with the Principal. Applications for admission to the course should also be made to the Principal. Early application is advised.

JOHN G. KELLETT,
Director of Education.
County Hall, Chester. E7156

UNIVERSITY OF SYDNEY

SENIOR LECTURESHIP AND LECTURESHIP/ SENIOR LECTURESHIP IN AERONAUTICAL ENGINEERING

Applications are invited for the above-mentioned positions. In each case the successful applicant will be required to lecture in Aero-dynamics and to avail himself of the excellent opportunities for research.

The salary for a Senior Lecturer is within the range £A2550 by £A95 to £A3000 per annum; for a Lecturer within the range £A1730 by £105 to £A2435 per annum. In each case cost of living adjustments will be allowed. The salary is subject to deductions under the State Superannuation Act. The commencing salary will be fixed according to the qualifications and experience of the successful applicant.

Under the Staff Members' Housing Scheme in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1.

Applications close, in Australia and London, on 31st December, 1960. E7117

BRADFORD INSTITUTE OF TECHNOLOGY

LECTURER IN MECHANICAL ENGINEERING

Applications are invited for the post of LECTURER IN MECHANICAL ENGINEERING.

Candidates should be well qualified and industrial and research experience would be a recommendation. The successful candidate will be required to teach one or more subjects to honours degree or Diploma in Technology standard. Adequate facilities will be given to undertake research and suitable assistance and equipment is available.

Salary scale : £1370 to £1550 per annum.

Previous industrial and research experience, at a suitable level, will be taken into account in fixing the commencing salary.

Further particulars and forms of application may be obtained from the Registrar, Bradford Institute of Technology, Bradford, 7.

HENRY PATTEN,
Clerk to the Governors.
E7159

PUBLIC APPOINTMENTS

WELSH COLLEGE OF ADVANCED TECHNOLOGY

DEPARTMENT OF ENGINEERING

LECTURERS

Applications are invited for the following posts, duties to commence as soon as possible.

1. LECTURER IN MECHANICAL ENGINEERING. Applicants must be University Graduates in Engineering, and should normally be graduates or corporate members of the Institution of Mechanical Engineers and have had adequate industrial experience.

2. LECTURER IN MECHANICAL ENGINEERING WITH SPECIAL KNOWLEDGE OF MARINE ENGINEERING. Applicants should be University graduates in Engineering or corporate members of the Institution of Mechanical Engineers and should preferably hold a first class M.O.T. Certificate together with at least graduate membership of the Institute of Marine Engineers.

Salary for both posts : £1370 to £1550 per annum, with placing upon the scale dependent upon experience.

Further particulars and forms of application may be obtained from the Registrar, at the College, Cathays Park, Cardiff, to whom completed forms should be returned by 3rd December, 1960.

ROBERT E. PRESSWOOD,
Clerk to the Governors.
City Hall, Cardiff. E7143

LONDON COUNTY COUNCIL

SOUTH EAST LONDON TECHNICAL COLLEGE LEWISHAM WAY, LONDON, S.E.4

ASSISTANT, GRADE "B"

ASSISTANT, GRADE "B" to teach scientific and/or Technical subjects, preferably including Mathematics or Chemistry to Engineering students. To commence 1 January, 1961, or as soon as possible thereafter. Salary : £700 by £27 10s. to £1150, plus £38 or £51 London Allowance, increments within scale for teaching and industrial experience.

Application forms from the Secretary.
Please quote (FE3a/E/2852/11). E7122

MINISTRY OF LABOUR

LEICESTER GOVERNMENT TRAINING CENTRE

INSTRUCTOR (UNESTABLISHED)

Ministry of Labour require Instrument Maker as INSTRUCTOR (UNESTABLISHED) at Leicester Government Training Centre. Must be British subject, experienced, fully skilled (normally for at least 5 years), able to teach his trade and supervise the work and maintain control of trainees. Should preferably possess O.N. or City and Guilds Certificate or equivalent qualification. Will be required to pass theoretical test before appointment and practical test of normal trade skills after taking up appointment. Prospect of eventual establishment. Salary : £955 (at age 30 or over), rising by annual increments to £1030 p.a. Write for application form to : Manager, Ministry of Labour, Government Training Centre, Humberstone Lane, Leicester, within 7 days. E7132

UNITED LIVERPOOL HOSPITALS

ENGINEERING ASSISTANT

Applications are invited for the post of ENGINEERING ASSISTANT to assist the Superintendent Engineer. The duties will include the preparation of drawings and specifications. Candidates should be competent draughtsmen and experienced in heating and ventilating and general engineering work and should hold the Higher National Certificate in Mechanical Engineering or its equivalent. The salary is on the scale £600 by £25(6) by £30(3) to £840 per annum and a candidate with suitable experience may enter the scale above the minimum. The Terms and Conditions of Service are those of the appropriate Whitley Council.

Apply stating age, qualifications, experience and the names and addresses of three persons to whom reference may be made to the Secretary, The United Liverpool Hospitals, 80, Rodney Street, Liverpool, 1, by the 2nd December, 1960. E7113

PUBLIC APPOINTMENTS

SOUTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD

REGIONAL ENGINEER'S DEPARTMENT

MAIN GRADE ENGINEERS

Applications are invited for appointments on the permanent staff of the Board generally in accordance with the Whitley Council conditions of service.

The Board is undertaking a considerable programme of hospital development and the persons appointed will be engaged on varied and interesting work.

MAIN GRADE ENGINEERS

Applicants should be (i) Corporate Members of the Institution of Mechanical Engineers and experienced in the preparation of specifications, drawings and estimates for large engineering installations in hospitals and large public buildings, or (ii) Corporate Members of the Institution of Heating and Ventilating, or (iii) have served a recognised engineering apprenticeship and be Graduate Members of the Institution of Mechanical Engineers, having passed A and B of the Associate Membership examination, or hold exempting qualifications. Sound experience of design of mechanical services of large buildings required. Drawing Office and Estimating experience an advantage.

Salary scale : £910 by £35 (1) by £40 (2) by £45 (2) by £50 (7) to £1600 p.a. Bar at £1205 for graduate members and at £1400 for Corporate members of the Institution of Heating and Ventilating. Corporate Members of the Institution of Mechanical Engineers commence between £1160 p.a. and £1300 p.a. London Weighting allowance of £40 to £50 p.a. payable in addition.

Applications, stating age, qualifications, experience, present appointment and salary, together with the names and addresses of three referees, should be sent to the undersigned at 40, Eastbourne Terrace, London, W.2, by not later than 1st December.

E. G. BRAITHWAITE,
Secretary.
E7155

SOUTH AUSTRALIA

CIVIL ENGINEERS

For qualified men with an ambition to get on with a job, there are good opportunities for permanent appointment in the Engineering and Water Supply Department in South Australia, with headquarters at Adelaide.

Vacancies exist in the design, construction, and maintenance branches, covering water supply and sewerage installations and other engineering projects.

Salary up to £A1920 per annum, according to experience and qualifications.

First class steamer passages for families provided. Housing accommodation guaranteed.

Good holiday entitlement and generous superannuation arrangements, providing retirement pension and widows' pension in case of pre-decease.

Full details from :
Agent General for South Australia,
South Australia House,
50 Strand,
London, W.C.2. E7152

PUBLIC APPOINTMENTS

HUNTINGDONSHIRE

COUNTY ARCHITECT'S DEPARTMENT

TECHNICAL ASSISTANT (HEATING ENGINEER)

Applications are invited for the above appointment within the Special Grade (£840 to £1145) or Grade A.P.T. III (£960 to £1140) according to qualifications and experience.

The person appointed will be a member of the Engineering Section of the Department, and his duties will consist of all works connected with heating installations related to both small and large building projects. Applicants must be competent draughtsmen with experience in the design of heating and allied services and they should hold the Ordinary National Certificate in mechanical engineering or be graduates of the Institution of Heating and Ventilating Engineers.

Application forms may be obtained from the County Architect, County Buildings, Huntingdon, and completed forms should be returned to the undersigned by Monday, 28th November, 1960.

A. C. AYLWARD,
Clerk of the County Council.
County Buildings, Huntingdon. E7047

MINISTRY OF AVIATION

ARDEER, AYRSHIRE

Ministry of Aviation, Ardeer, Ayrshire, requires TECHNICIAN for control and supervision of staff engaged on inspection of propellant and explosive stores at group of commercial factories in S.W. Scotland. Qualifications : Recognised Engineering apprenticeship. H.N.C. or equivalent. Wide experience of inspection and manufacture of propellant and explosive stores. Knowledge of small arms ammunition proof and experience in use of electrical test equipment an advantage. Salary : £1055 to £1295. Forms from Ministry of Labour, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C 869/OA. E7133

COUNTY BOROUGH OF EAST HAM

JUNIOR ENGINEERING ASSISTANT (MECHANICAL) A.P.T. I

JUNIOR ENGINEERING ASSISTANT (MECHANICAL) A.P.T. I : Salary up to £855 per annum.

A subsistence allowance may be granted over a reasonable period to the person appointed if unable to obtain suitable housing accommodation, necessitating the maintenance of two homes.

Further details and application form returnable by 2nd December, 1960, from the Town Clerk, Town Hall, East Ham, E.6. E7139

DEPUTY REGIONAL ENGINEER

Required by WELSH REGIONAL HOSPITAL BOARD

Applicants must be Corporate Members of the Institution of Civil or Mechanical or Electrical Engineers and preference will be given to persons with previous experience in the Hospital Service.

The successful candidate will deputise for the Regional Engineer over the whole range of duties for which he is responsible and should have a sound administrative background as well as considerable experience in engineering design. He should be able to provide the Board and its staff with authoritative advice and guidance when required in all branches of engineering work and services in hospitals and be responsible for the day to day supervision of the Engineer's Department.

Salary : £1865 by £85 (1) by £100 (3) to £2250.

The post is superannuable and a five-day week applies.

Applications to Secretary, Temple of Peace and Health, Cathays Park, Cardiff, stating age, qualifications, experience, present position and salary, with names of two referees, within 14 days.

E7144

Classified Advts. continued on page 136

PUBLIC APPOINTMENTS

THE ROYAL COLLEGE OF SCIENCE & TECHNOLOGY GLASGOW

Applications are invited from honours graduates for a

RESEARCH STUDENTSHIP

in the Department of Mechanical, Civil and Chemical Engineering, annual value £500. The Studentship will be tenable for three years and should normally lead to higher degree.

The successful applicant will be required to undertake research on the strength and stability of thin walled structural forms. Forms of application from the Secretary, George Street, Glasgow, C.1.

E7151

TENDERS

N.A.T.O. COMMON INFRASTUCTURE

SLICE VIII

NAVAL BASE INSTALLATIONS

FINAL NOTICE is hereby given that International Competitive Bids will be INVITED on or about 28th December, 1960, for the SUPPLY and INSTALLATION OF PUMPING EQUIPMENT at a P.O.L. Storage Depot to be built in the Campbeltown area of Scotland.

2. The approximate cost of the contract will be £32,000 and will include :

(a) For duty on furnace fuel oil :
THREE Steam Turbine-driven Centrifugal Pumps about 1100 cubic metres per hour capacity each.

(b) For duty on white oils :
THREE Electric Motor-driven Centrifugal Pumps about 50 cubic metres per hour capacity each.
THREE Electric Motor-driven Centrifugal Pumps about 22 cubic metres per hour capacity each.

(c) For duty on ballast :
ONE Electric Motor-driven Screw Displacement Pump about 50 cubic metres per hour capacity.

(d) For duty on water :
ONE Electric Motor-driven Centrifugal Pump about 41 cubic metres per hour capacity.
ONE Diesel Engine-driven Centrifugal Pump about 41 cubic metres per hour capacity.

3. The work will be carried out as one contract which will be undertaken as a sub-contract within the framework of the Main Contract for the contion of the depot. Bids for the Main Contract will be invited shortly.

4. It should be noted that the importation of labour from sources outside of the United Kingdom may be subject to restriction and that permission could in any case only be given on an undertaking that the Contractor would pay rates of wages and observe hours and conditions of labour not less favourable than those established for U.K. labour for the trade or industry in the same area.

5. The closing date for the recipt of bids will be 28th February, 1961.

6. Firms wishing to bid must formally notify their desire by application to the address below by 28th November, 1960.

7. Within one week after the closing date for the receipt of applications to bid, firms wishing to be invited must forward the following information :

(i) Statement of financial resources and evidence of financial stability.

(ii) Details of recent major contracts completed for work of a comparable nature including an indication of the value of each.

8. Enquiries regarding bidding should be addressed to :

Director General, Navy Works,
Admiralty,
Chamberlain Way,
Pinner,
Middlesex,
England

quoting reference NWD/Infra/19 (Sub-Contract Pumps). E7109

METROPOLITAN WATER, SEWERAGE & DRAINAGE BOARD

NEW SOUTH WALES

AVON-SOUTH COAST WATER SUPPLY

CONTRACT NO. 3462-W

TENDERS are invited for the MANUFACTURE, SUPPLY, TESTING, DELIVERY and INITIAL MAINTENANCE of TWO, alternatively, THREE or FOUR Automatic Needle Type Inlet Control Valves 30in. nominal bore with Associated Electric D.C. motors and Control gear ; also Two alternatively Four 30in. diameter Manually-Operated Stop Valves.

Tender documents, including the specification and drawings, can be obtained on application to the Agent-General for New South Wales, 56 Strand, London, W.C.2.

Tenders must be submitted to the Metropolitan Water, Sewerage and Drainage Board, 341, Pitt Street, Sydney, New South Wales, Australia, by 2 p.m. on Tuesday, 13th December, 1960. E7146

TENDERS

N.A.T.O. COMMON INFRASTRUCTURE

SLICE VIII

NAVAL BASE INSTALLATIONS

FINAL NOTICE is hereby given that International Competitive Bids will be invited on or about 28th December, 1960, for the SUPPLY and INSTALLATION of Jetty Oil Flow-Boom Equipment at a P.O.L. Storage Depot to be built in the Campbeltown area of Scotland.

2. The approximate cost of the contract will be £32,000 and will comprise :

ONE COMPLETE OIL FLOW-BOOM equipment for :

SEVEN 10-inch HOSE CONNECTIONS and including ONE LIGHT DERRICK.

3. The work will be carried out as one contract which will be undertaken as a sub-contract within the framework of the Main Contract for the construction of the depot. Bids for the Main Contract will be invited shortly.

4. It should be noted that the importation of labour from sources outside of the United Kingdom may be subject to restriction and that permission could in any case only be given on an undertaking that the Contractor would pay rates of wages and observe hours and conditions of labour not less favourable than those established for U.K. labour for the trade or industry in the same area.

5. The closing date for the receipt of bids will be 28th February, 1961.

6. Firms wishing to bid must formally notify their desire by application to the address below by 28th November, 1960.

7. Within one week after the closing date for the receipt of applications to bid, firms wishing to be invited must forward the following information :

(i) Statement of financial resources and evidence of financial stability.

(ii) Details of recent major contracts completed for work of a comparable nature including an indication of the value of each.

8. Enquiries regarding bidding should be addressed to :

Director General, Navy Works,
Admiralty,
Chamberlain Way,
Pinner,
Middlesex,
England

quoting reference NWD/Infra/19 (Sub-Contract Flow-Boom Equipment). E7108

DUNMOW RURAL DISTRICT

CONTRACT NO. 15A

GREAT EASTON AND DUTON HILL SEWERAGE EXTENSIONS

TENDERS are invited on a FIXED PRICE Basis in accordance with the Ministry of Housing and Local Government Circular No. 31/57 for the CONSTRUCTION of SEWERAGE EXTENSIONS at Great Easton and Duton Hill (being completion of a contract started by a contractor who has gone into voluntary liquidation).

The sewerage comprises in all the laying of about 3000 1in. yards of 6in. diameter S.G.W. sewer, together with 4in. and 6in. diameter S.G.W. house connections, the construction of 7 brick manholes and 24 precast concrete manholes and ancillary works.

General Conditions of Contract, Specification, Bills of Quantities and drawings may be obtained from the Council's Consulting Engineers, Messrs. J. D. and D. M. Watson, MM.I.C.E., 67, Tufton Street, Westminster, S.W.1, on and after 21st November, 1960, on payment of a deposit of ten guineas, refundable only to Contractors who submit bona fide Tenders and return all documents and drawings. Deposit cheques should be made payable to Dunmow Rural District Council.

The Council do not bind themselves to accept the lowest or any Tender.

Tenders must be returned in envelopes which do not bear any name or mark indicating the sender, endorsed " Tender for Sewerage Contract No. 15A," and delivered at the office of the undersigned not later than 9 a.m. on 19th December, 1960.

F. A. RENNISON,
Clerk of the Council.

Dunmow Rural District Council,
Council Offices,
Dunmow, Essex. E7093

INDIA STORE DEPARTMENT

The Director General of India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :

	Tons
Steel, Sheet, Bulletproof, Austenitic, Manganese (or equivalent), non-magnetic, Softened or Toughened BLANKS, 17in. diameter by 20 BG	5

Forms of Tender may be obtained from the above address on or after the 18th November, 1960, free of charge.

Tenders are to be delivered by 2 p.m. on Thursday, 15th December, 1960.

Please quote reference No. 46/58/DB/RLY.2.

E7136

COUNTY BOROUGH OF BLACKPOOL

TENDERS (forms from Chief Education Officer, 3 Caunce Street, Blackpool), returnable by 2.30 p.m. on Tuesday, 29th November, 1960, invited for the SUPPLY of ONE " SMART & BROWN " No. 1024 PRECISION TOOLROOM LATHE and accessories. E7126

TENDERS

INDIA SUPPLY MISSION

The Office of the India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington 8, D.C., United States of America, invites TENDERS for the SUPPLY of the equipment as listed below, required for the manufacture of Streptomycin by Hindustan Antibiotics, Ltd., India.

Indent No.	Tender Enq. No.	Brief description of equipment required	Closing date	Price for Tender
PUR/ISM/ STR/120 ...	SE-281	Argon Arc Torch, Spot Welder (Portable) D.C. Welding Sets	January 10, 1961	$0.50=3s. 7d.
PUR/ISM/ STR/121 ...	SE-282	10-ton Pulley Block	January 10, 1961	$0.50=3s. 7d.
PUR/ISM/ STR/122 ...	SE-283	Fittings for S.S. Tubing	January 12, 1961	$1.00=7s. 2d.
PUR/ISM/ STR/123 ...	SE-284	Pyrex pipe, Fittings and Accessories	January 17, 1961	$1.00=7s. 2d.
PUR/ISM/ STR/124 ...	SE-285	PVC Pipe Fittings and Accessories	January 17, 1961	$1.00=7s. 2d.

Specifications, etc., relative to the above specifications can be obtained from the Co-ordination Branch, India Store Department, Bromyard Avenue, Acton, London, W.3. The cost of Tender sets are as indicated above and are not refundable.

Tenders are to be returned direct to India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington 8, D.C., United States of America, *and not to this Office*, and are to reach them on the dates specified above against each enquiry number.

Specimen copies of the above enquiries can be seen at Engineering Branch, India Store Department, Government Buildings, Bromyard Avenue, Acton, London, W.3. under the above Tender reference numbers.

E7137

WEST CORNWALL WATER BOARD

DRIFT WATER SCHEME

CONTRACT NO. 8

LUDGVAN AND TREVELYAN SERVICE RESERVOIRS

The Board invites FIXED PRICE TENDERS from EXPERIENCED CONTRACTORS for the CONSTRUCTION of TWO CONCRETE SERVICE RESERVOIRS : LUDGVAN with a capacity of 500,000 gallons and TREVELYAN with a capacity of 150,000 gallons, on sites in West Cornwall.

Tenders will be accepted for either or both reservoirs.

The reservoirs are of similar design being rectangular in plan with normally reinforced concrete walls, columns and flat slab roof.

The General Conditions of Contract, Specification, Bill of Quantities and Form of Tender for this Contract, prepared by the Engineers, Herbert Lapworth Partners, 25, Victoria Street, Westminster, S.W.1, may be obtained from the Undersigned on or after Monday the 21st November, 1960, on receipt of an application stating the reservoir for which documents are required and payment of a deposit of £2 2s. by cheque for each reservoir, made payable to the West Cornwall Water Board, which sums will be returned on receipt of a bona fide Tender.

Tenders, together with all documents received are to be enclosed in a sealed cover endorsed " Drift Water Scheme—Tender for Contract No. 8 " and addressed to the Undersigned and delivered not later than 10 a.m. on Monday, 19th December, 1960.

Only Tenders from firms experienced in this type of work will be considered.

The Board do not bind themselves to accept the lowest or any Tender.

E. O. WHEALE,
Clerk to the Board.

Municipal Buildings,
Penzance. E7115

CITY OF CARDIFF

CORPORATION WATERWORKS

TENDERS FOR THE CONSTRUCTION OF THE LLANDEGFEDD IMPOUNDING RESERVOIR

The date for receipt of TENDERS for the CONSTRUCTION of the above works has been extended from the 22nd November, 1960, to the 2nd December, 1960.

S. TAPPER-JONES,
Town Clerk.

City Hall,
Cardiff. E7123

WEST CORNWALL WATER BOARD

CONTRACT NO. 13—MADRON WATER SCHEME

PIPELAYING

The Board invites FIXED PRICE TENDERS from EXPERIENCED CONTRACTORS for EXCAVATING FOR, SUPPLYING, LAYING, JOINTING, and the MAINTENANCE of about ¼ mile of spun iron pipes with Tyton joints, together with Valves and Fittings, etc., and the SUPPLY and ERECTION of two Booster Pumps and Switch Gear, &c.

The General Conditions, Specification, Bill of Quantities and Form of Tender for this Contract, prepared by the Engineers, Herbert Lapworth Partners, 25, Victoria Street, Westminster, S.W.1, may be obtained from the Undersigned on or after Monday the 21st November, 1960, on receipt of a cheque for £5 made payable to the West Cornwall Water Board, which sum will be returned on receipt of a bona fide Tender.

Tenders, together with all documents received are to be enclosed in a sealed cover endorsed " Madron Water Scheme—Tender for Contract No. 13—Pipelaying," and addressed to the Undersigned and delivered not later than 10 a.m. on Monday, 19th December, 1960.

Only Tenders from firms experienced in this type of work will be considered.

The Council do not bind themselves to accept the lowest or any Tender.

E. O. WHEALE,
Clerk to the Board.

Municipal Buildings,
Penzance E7114

EDUCATIONAL

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Four weeks' full-time concentrated practical course for Executives.
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2. Commences 10th April, 1961.

PRODUCTION PLANNING AND CONTROL
Three weeks' full-time course for Production Planning and Control Executives.
1. Commences 6th March, 1961.
2. Commences 12th June, 1961.

Write NOW for reservation form and further details to :
Ref. DS/CLW,
Woolwich Polytechnic, London, S.E.18.

E7142

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A comprehensive treatment of foundry work which provides not only a practical guide for operatives but also an authoritative textbook of the subject covering the syllabus of the City and Guilds of London Institute for intermediate students and including specimen examination questions. 30s. net

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The importance of this book will be obvious to those working in this field. 47s. 6d. net.

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LOUGHBOROUGH COLLEGE OF TECHNOLOGY

INTRODUCTORY COURSES ON ERGONOMICS

The College provides A THREE WEEK introductory course on ERGONOMICS, for engineers, designers, industrial medical officers, work study engineers, factory managers and all senior staff who are called on to deal with human factor questions. The aim of the course is to impart a general knowledge of the capabilities and limitations of human performance at industrial work tasks. Such factors as the ergonomics of work place layout, factory operation and maintenance, noise, lighting and seating in factories and offices, will be considered in relation to the design of equipment and the industrial effectiveness and well-being of employees. This short course will enable those who take it to appreciate the applications of ergonomics in their own industries.
Dates of the next course: Monday, 6 March, 1961, to Friday, 24 March, 1961.
Fees: £75 including tuition, board and residence.
Applications and further details may be obtained from the Head of the Department of Ergonomics and Cybernetics, College of Technology, Loughborough, Leicestershire. E7161 B

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

AEI—BIRLEC LIMITED
manufacturers of industrial furnaces, wish to appoint a
WORKS MANAGER
having full responsibility for all Manufacturing activities at the Company's Erdington and Aldridge Factories. He will report to the appropriate Director of the Board.
A really outstanding man is required for this post and an appropriate salary will be paid. There is an excellent pension scheme and other benefits.
Please write, giving details of education, qualifications and experience to—
The Managing Director,
AEI-BIRLEC LIMITED,
Erdington,
Birmingham, 24.
E3077 A

ASSISTANT CHIEF PLANNING ENGINEER
Mid-Warwickshire firm has a vacancy for a man with knowledge of production machining of cast-iron and non-ferrous metals, press work and sheet metal work and some experience of medium-sized assembly work. Knowledge of electrical work advantageous. Work will be to introduce new methods of production and investigation of faults, and will entail planning from blueprint stage through prototype to production. Preferred age 25-35. Minimum starting salary £950 depending on age and qualifications.—BOX No. E3081, "The Engineer." A

ASSISTANT ENGINEER, aged 28-35, required at large North East Coast Brewery Company. The successful applicant will be directly responsible to the Chief Engineer for the maintenance of brewery and bottling plant and to assist in the planning and installation of new plant. Applicants should preferably have had previous experience with brewery plant and maintenance, but this is not essential. Applicants should also be members of a recognised engineering institution.—Applications, which should be made in writing, should give details of technical training, practical experience and positions held, and should be addressed to BOX No. E3080, "The Engineer." A

ASSISTANT RESIDENT ENGINEER
required for long-term Coke Oven and By-Product contract in Yorkshire. Age 23-27 years. Degree or H.N.C. (Civil) desirable. Must be interested in the construction of complete industrial plants, including structural steelwork, pipework, heavy vessels and refractory brickwork. Should be prepared to travel at end of the contract. A permanent staff appointment with pension rights and good prospects. Salary in accordance with qualifications and experience.—Applications quoting reference AR150 in confidence to Contract Labour Department, Simon-Carves, Ltd., Cheadle Heath, Stockport.
E7145 A

ASSISTANT WORKS MANAGER wanted with sound knowledge of steel fabrications and the use of jigs and fixtures.—BOX No. E3073, "The Engineer." A

CIVIL ENGINEERING DRAUGHTSMAN required for Oil Refinery. Must be familiar with surveying and setting out work. Experience of Contractors' work is desirable. Applicants should give, in writing, particulars of their experience and qualifications, upon which the salary will depend. This is a permanent position. Non-Contributory Superannuation Scheme and subsidised canteen meals.—Applications should be made to the Refinery Manager, Lobitos Oilfields Ltd., Ellesmere Port, Cheshire. E7131 A

CHIEF DRAUGHTSMAN. First class designer required for this post with firm of General Engineers in Bristol. Good knowledge of design of Pressure Vessels and stainless steel fabrications, with particular reference to the requirements of BS.1500. This will be a well paid position for the top class man.—BOX No. E199, "The Engineer." A

CONSULTING ENGINEERS require ASSISTANT ENGINEERS for office in Nigeria. Candidates should have experience in design of roadworks and knowledge of urban drainage an advantage. Salary range £1300 to £1600 depending on experience. Free furnished accommodation, car allowance and fares provided. Fifteen months tour with three months paid leave.—Apply in writing, stating age, experience, &c., to R. Travers Morgan & Partners, 60, Rochester Row, S.W.1. E7119 A

CROSSE & BLACKWELL require in London, two qualified ENGINEERS to join their development team engaged in overall expansion programmes and in the application of Food Engineering techniques in the widest sense. These are senior positions commanding rewarding salaries and will appeal to men who are prepared to work hard and prove themselves in this field. Food experience would be advantageous but the ability to collect facts and produce results is the first importance.—Write in confidence to: Chief Engineer, Crosse & Blackwell Ltd., 20, Soho Square, London, W.1. E7112 A

DRAUGHTSMEN

Pilkington Brothers Limited have vacancies in their Technical Development Department for three senior and one junior Mechanical Draughtsmen. The work involves the production of design and detail drawings for new plant and for modifications to existing machines. The draughtsmen work closely with Development Engineers on a wide range of problems from small precision mechanisms to automatic glass-handling equipment.

Age range: Senior 25-45; Junior 21-25.

Qualifications: Seniors H.N.C. preferred, but general engineering experience essential. Junior preferably with O.N.C. and general engineering apprenticeship.

Applications, stating age, qualifications and experience, should be addressed to Mr. C. S. Drake, Group Staff Department, Pilkington Brothers Limited, St. Helens, Lancashire.

E7085 A

ENGINEER, age 20-35, with electronic, electrical or mechanical engineering background, required for editorial staff of a successful industrial journal published in London. Applicants, who need not have previous journalistic experience, must be able to write clearly and concisely on technical subjects.—Reply, giving full details of age, education, training and experience, to BOX No. E7138, "The Engineer." A

ENGINEER SURVEYORS for the inspection of boiler and pressure plant required. Applicants should not be more than 38 yrs. and must have 1st Class M.O.T. Certificate with steam endorsement or equivalent qualifications. Salary E.S.A. Scale starting at £800 per annum. Other benefits. Areas Oxford and Windsor.—Apply Eng. Dept., GENERAL ACCIDENT ASSURANCE CORP., LTD., 99, Aldwych, London, W.C.2. E7110 A

ESTIMATING ASSISTANT for London Office of large North country Engineering concern. Applicants should hold O.N.C. or preferably H.N.C. and be 22 or over.—Full details of past experience and present employers should be stated in strict confidence to BOX No. E7106, "The Engineer." A

FIRM OF CHARTERED QUANTITY SURVEYORS require TAKERS OFF and WORKERS UP for large Civil Engineering and Building works in the Sheffield area. Positions offer scope for advancement.—Reply, stating age, experience and salary required to BOX No. E3072, "The Engineer." A

FIRST CLASS DESIGN DRAUGHTSMAN required for London office of well known public company, accustomed to designing Road Transport Tanks for Liquids and Powders. Good salary offered with prospects of promotion.—Write BOX No. E3076, "The Engineer." A

MECHANICAL ENGINEER, H.N.C. standard, required for non-destructive testing of materials and vessels. Specialised training will be given to successful candidate. Commencing salary £800 a year. Non-contributory pension.—BOX No. E7149, "The Engineer." A

MERZ AND MCLELLAN have vacancies in their Esher Office for MECHANICAL ENGINEERING DRAUGHTSMEN. Preferred age limits 25 to 35. Applicants should be experienced in Plant Layout Work, preferably, but not essentially, in connection with Power Stations. Salaries will be fully appropriate to experience, rising from about £870 per annum at age 25. Excellent working conditions. Pension Scheme. Canteen.—Apply in writing to Merz and McLellan, Milburn, Esher, Surrey. E7071 A

SCOTTISH AGRICULTURAL INDUSTRIES LIMITED have a vacancy for an experienced WORKS STUDY OFFICER with engineering qualifications. Candidates should be between 23 and 35 years of age and should have had not less than 2 years' experience in Work Study and the application of Incentive Schemes based on Work Study.
The post is permanent and pensionable and the starting salary offered will be related to age, qualifications and experience.
Application forms will be forwarded to suitable candidates on receipt of brief details of age, qualifications, and experience, addressed to the Personnel Officer, Scottish Agricultural Industries Limited, 39 Palmerston Place, Edinburgh, 12. Tel. No.: CAL 2581, quoting Ref. No. 25. E7125 A

Classified Advts. continued on page 138

SITUATIONS VACANT

STEIN ATKINSON VICKERS HYDRAULICS LTD. wish to appoint a SENIOR APPLICATIONS ENGINEER for their London Offices. A sound practical knowledge of all types of machine tools is essential including some experience of Oil Hydraulics. This post relates to the application of Hydraulic equipment, and involves the preparation of circuits, quotations and technical discussions with user Engineers. The applicant should have served an Engineering apprenticeship. A degree or similar qualifications would be an advantage.—Please apply in writing, stating salary expected, to Chief Applications Engineer, Stein Atkinson Vickers Hydraulics Ltd., 197, Knightsbridge, London, S.W.7.

E7121 A

TECHNICAL WRITER

required in the Sales Promotion and Development Branch of the National Coal Board. The principal duties will be in the preparation of promotional booklets and literature related to the use of solid fuel in industry and commerce. Applicants should have experience in the technical journalism of steam and combustion engineering, or practical experience in these subjects and the ability to write effectively on them. Appointment superannuable, salary depending on qualifications and experience within £1190 to £1560.—Write for application form to Staff Dept. (X.2046A), N.C.B., Hobart House, London, S.W.1, before 2nd December, 1960.

E7160 A

THE BRITISH OXYGEN CO. LTD., Scientific Division, have a vacancy for a MECHANICAL ENGINEER to undertake development work on pumps for fluids at low temperatures. Applicants should have a degree in mechanical engineering or equivalent qualifications and preferably some experience of pump design.

Please write to the Administration Manager, The British Oxygen Co. Ltd., Scientific Division, Deer Park Road, London, S.W.19. E7154 A

WORKS MANAGER. Applications are invited to fill the vacancy of Works Manager in a well known General Engineering Factory in North-West London. Candidates must be experienced Engineers, preferably qualified and should possess higher executive ability. A qualification in Costs and Works Accountants examinations would be an advantage. This post offers excellent prospects to suitable candidate.—Write with fullest details of age, qualifications and experience in confidence to : BOX No. E7163, " The Engineer." A

WORKS MANAGER required for West Riding of Yorkshire gear manufacturing firm of medium size. Non-contributory pension scheme in operation. Applicants must have full practical qualifications for the position. Salary required to be specified on application.—BOX No. E3074, " The Engineer." A

SITUATIONS VACANT

HEATING AND VENTILATING ENGINEERS AND DRAUGHTSMEN

Assistant Design Engineers are required by the United Kingdom Atomic Energy Authority at Risley, to undertake individual design work of a high standard or lead small teams of draughtsmen on design of high and low pressure hot water and steam heating systems ; hot water supply installations ; ventilation and air conditioning systems.

Draughtsmen are also required to assist in the preparation of engineering drawings and plans.

Applicants for posts as Assistant Design Engineers must have served a recognised engineering apprenticeship or have had equivalent training. Good design experience in this field, and possession of an appropriate H.N.C., are essential.

Applicants for posts as Draughtsmen must have an appropriate O.N.C. or equivalent, and must have had good practical training with sound experience.

Graduate membership of the Institution of Heating and Ventilating Engineers may be an advantage for all posts.

Salaries for Assistant Design Engineers will be between £930 and £1340.

The salary scale for Draughtsmen is under review, and is expected to be about £600 at age 21 rising to about £800 at age 25, and to a maximum of about £1000.

Contributory Superannuation. Housing Assistance Schemes.

Send postcard for application form, quoting reference 421/J1, to :

The Appointments Officer,
U.K.A.E.A.,
DEVELOPMENT AND ENGINEERING GROUP HEADQUARTERS,
Risley, Warrington, Lancashire.

Closing Date: 5th December, 1960

E7127 A

SITUATIONS VACANT

CHIEF ENGINEER

required for Rubber Works, London area, with rubber and plastics machinery experience. Preferably A.M.I.Mech.E., A.M.I.E.E., or equivalent. 35/50 years. This is an executive position calling for powers of leadership and proven administrative ability. Applicants to apply in first instance in own handwriting giving brief outline of experience together with age and qualifications, also salary expected. Pension Scheme.—BOX No. E3083, " The Engineer. " A

SITUATIONS VACANT

TOOLING MANAGER

Applications are invited for the position of Tooling Manager with a large Plastics Moulding Company.

The type of man for whom we are looking will have served a toolmaking apprenticeship, attained H.N.C. or membership of one of the recognised engineering institutions, had tool design experience and practical administrative experience in a similar position in a Toolroom. This position carries responsibility for all aspects of the manufacture of all types of tools including vacuum and sheet forming tools, injection and compression dies and all associated jigs, fixtures and ancillary equipment.

The successful applicant will be expected to work closely with other technical and administrative personnel.

There is opportunity for an excellent career and applicants should submit details of their age, qualifications and experience to BOX No. E7141, " The Engineer."

A

MSL *have been retained to advise on the appointment of a*

TECHNICAL MANAGER

for a company in the South of England specialising in the design, development and construction of heavy machinery for the steel and allied industries. He will be responsible to the Divisional Manager (Director) for technical sales activities and the engineering of hot rolling mills to the contract stage. Salary around £2,500, contributory pension scheme.

Candidates, qualified mechanical engineers, preferably over 35, must have specialised knowledge and experience either in the design and construction, or the operating of hot rolling mills. As some European travel will be involved, the ability to speak French or German would be an advantage, but is not essential. Please send brief details in confidence quoting reference G. 3200 to H.C.S. Brand.

MANAGEMENT SELECTION LIMITED,
17 Stratton Street, London, W.1.

In no circumstances will a candidate's identity be disclosed to our client unless he gives permission after a confidential interview at which he will be given full details of the appointment.

E134 A

CHIEF DESIGNER

for a leading manufacturer of earthmoving equipment located in the pleasant countryside of North-West England. This executive appointment will carry a starting salary in the bracket £1800—£2200 per annum which is open to subsequent improvement. Removal expenses will be met. Residential and educational amenities are excellent.

The Chief Designer will have responsibilities to the Managing Director for the execution of basic design and engineering development of a range of modern equipment. He will be a full member of the Product Development and Component Standardisation committees. In addition, he will control the preparation of technical publicity material including spare parts catalogues, instruction and service manuals.

Among the desired qualifications are experience of the control of design draughtsmen engaged on medium to heavy stressed fabrications, together with wide personal knowledge of the design of gears and transmission systems. Experience in the application of hydraulic systems would be an advantage. A.M.I.Mech.E. desirable. Age up to 50.

Please write briefly in first instance, quoting Reference No. 920, *to :—*

ASHLEY ASSOCIATES LTD.
PETER HOUSE, MANCHESTER 1.
RETAINED TO ADVISE ON THIS APPOINTMENT
The strictest confidence will be observed and no details of candidates will be passed to clients without candidates' permission.

E7162 A

TAYLOR WOODROW CONSTRUCTION LIMITED

require experienced staff for

CIVIL ENGINEERING DESIGN AND DEVELOPMENT

OF NUCLEAR POWER AND INDUSTRIAL WORKS

at Southall (Middlesex) and Whetstone (Leicestershire)

SENIOR DESIGN ENGINEERS to take charge of work on power station layout and development ; heavy civil engineering, concrete and steel structures, and hydraulics.

ASSISTANT DESIGN ENGINEERS. DESIGNER DRAUGHTSMEN AND JUNIOR DRAUGHTSMEN for similar work.

SENIOR RESEARCH ENGINEERS AND ASSISTANT RESEARCH ENGINEERS Well qualified, and with good experience of reinforced concrete design, for research into applications relating to nuclear power.

SENIOR PLANNING ENGINEERS for investigation into construction methods related to power station design studies.

ARCHITECTS for power station work.

Opportunities for advancement to selected applicants willing to work hard and accept responsibility. Interviews can be arranged at Southall or Whetstone at any time including evenings and Saturday mornings, with travelling expenses paid.

Write, giving details of career, to :

Personnel Manager, 345, Ruislip Road, Southall, Middlesex

Alternatively, our office at 10, Park Street, W.1., will be open from 5 to 7p.m. on Thursday evenings until the end of January for informal discussions (without prior appointments) with senior members of our engineering staff.

E7157 A

SITUATIONS VACANT

RENOLD CHAINS LIMITED

invite applications for positions as

HOME SALES REPRESENTATIVES

Qualifications :

Engineering Apprenticeship, preferably Mechanical
Higher National Certificate
Personal qualities and appearance appropriate to Salesmanship.

External selling experience is not essential. Successful applicants will be appointed initially to the Home Sales Department at Renold House, Manchester, for a period of extensive training.

Please write fully to :

Personnel Officer (Men),
RENOLD CHAINS LIMITED,
Renold House,
Wythenshawe, Manchester

E7118 A

SITUATIONS VACANT

TECHNICAL ADVISER LUBRICANTS

Engineer, fully qualified required by Independent North of England Lubricating Oil Manufacturers. Age 30/40. Duties include technical assistance to sales, plant surveys, development. Must have diesel experience. Progressive position for applicant with initiative. Contributory pension scheme. Write full particulars of experience, qualifications and salary required to Box No. E7153, "The Engineer."

A

SITUATIONS VACANT

DRAUGHTSMEN

having specialised experience in transmission, hydraulics, earth-moving and construction machinery, electric motors, or switchgear are invited to make application for positions which have been created by a vigorous expansion programme. Positions will carry attractive salaries, and offer scope for advancement in a progressive Company. Modern offices and canteen facilities.

Please give full details of age, qualifications and experience in chronological order to the Secretary, British Jeffrey-Diamond Ltd., Stennard Works, Wakefield.

E7135 A

RTB

RICHARD THOMAS & BALDWINS LIMITED

SPENCER WORKS

invite applications for the post of

CRANE AND LIFTING APPLIANCE ENGINEER

This position will involve the co-ordination of standards for all cranes and lifting equipment. The engineer appointed will be responsible for all statutory testing and relevant records and must be capable of advising plant engineers on suitable maintenance methods. His duties will also include the training of crane-drivers and associated personnel, together with the setting up of safety procedures for crane operation.

Candidates, preferably between the ages of 30 and 55, should be corporate members of the Institution of Mechanical Engineers or hold an equivalent qualification. Preference will be given to candidates who have considerable experience in this field.

Application forms, which should be returned by December 1, 1960, may be obtained from

The Manager, Staff & Labour Relations Dept.,
RICHARD THOMAS & BALDWINS LIMITED,
Spencer Works, Llanwern, Nr. Newport, Mon.

Please quote reference 200/7 on your original letter of enquiry.

E7124 A

An experienced PLANT MAINTENANCE ENGINEER

is required by a substantial West Midlands Company. This is not a desk bound job, but requires a really first class practical Engineer able to "get things done." Must be able to control labour and lead by example. This appointment will suit an Engineer 40-55 years old, who has had some years experience as a Superintendent on Works Maintenance, and who is prepared to get his teeth into a job both interesting and absorbing.

Salary by arrangement, together with Superannuation and Insurance Benefits.

Write in strictest confidence details of experience, career to date and salary required to Personnel Manager, BOX No. E7128, "The Engineer."

A

CHIEF PRODUCTION ENGINEER

(Light Engineering)

for one of the main manufacturing divisions, located in Manchester, of a major engineering group. This is a new appointment, offering an opportunity to take over and develop a young energetic department. Initial salary will be in the range £1500 to £1750 per annum, plus usual benefits.

The Chief Production Engineer, who will be responsible to the Works Manager, will have full control of a staff of 30 engaged on methods engineering, work study, jig and tool design and manufacture. The major emphasis and scope in this appointment lie in manufacturing methods improvement, lay-out and tool and special-purpose machine developments. There will, at the same time, be a continuing responsibility for ensuring that work study applications are kept up to date.

The main essential qualifications are an engineering apprenticeship, and not less than five years' close personal contact—including a period in control of production engineering functions—with press work, tool design, precision welding, machining and assembly. A professional qualification would be an added advantage. Preferred age 30-42.

Please write briefly in first instance, quoting Reference No. 885, to :—

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E7148 A

HARDY SPICER LTD.

requires a

DEVELOPMENT MANAGER

in its Engineering Division to take charge under the Chief Engineer of all road and static test and development work, leading a team of development engineers and technicians. This is a new and additional appointment.

Applications are invited from chartered mechanical engineers with considerable development experience—preferably related to the motor industry—who can demonstrate the capacity to control and lead a development team. An appreciation of electronic techniques in the control and measurement of development work is important. Likely age range 35-45.

Salary and conditions will be appropriate to this senior appointment.

Applicants should write to the Personnel Director, Hardy Spicer Ltd., Chester Road, Birmingham, 24, giving full particulars. Interviews will be arranged at times and places of mutual convenience.

E7129 A

Classified Advts. continued on page 140

SITUATIONS VACANT

The following vacancy occurs

DUE TO FURTHER EXPANSION

PRODUCTION MANAGER

to be responsible for the production of magnetic recording equipment. Candidates should have proved experience in the field of precision mechanisms and possess A.M.I.Prod.E. or equivalent qualification. A high degree of organisational ability is required, together with a first-class capacity for forward planning. Initial salary £1,350—£1,600.

The above vacancy, whilst demanding ability of a high order, offers an exceptional opportunity to join a rapidly expanding Company at a relatively early stage in its development and prospects of advancement are therefore unusually good. The Company operates a Superannuation Fund. Applications, which will be treated in confidence, giving details of career and quoting reference 501, should be addressed to :—

C. Hardy, Director,
DATA RECORDING INSTRUMENT COMPANY LIMITED,
Woodthorpe Road,
Ashford,
Middlesex.

E3075 A

SITUATIONS VACANT

APC

have vacancies in their Central London Technical Department for senior and junior

MECHANICAL ENGINEERS
ELECTRICAL ENGINEERS
PHYSICISTS
MATHEMATICIANS

for theoretical work on heat transfer; reactor and steam plant optimisation, control and performance; reactor physics; radiation shielding; analogue computing.

The Company owns an Emiac II Analogue Computer and uses the Ferranti Mercury Digital Computer.

Applicants should hold a good honours degree and engineers should have had some industrial experience.

Applications giving full details should be sent to :—

The Personnel Manager (Ref. TE/156),
Atomic Power Constructions Limited,
P.O. Box 90,
28 Theobalds Road,
London, W.C.1.

E7158 A

MECHANICAL ENGINEERS

Young mechanical engineers with imagination will enjoy the challenge of design and development work in I.C.I. Nobel Division. Some posts are vacant and will be filled by men with degrees in mechanical engineering who are under thirty years of age.

For men of quality, prospects of rapid promotion are excellent, in an environment that encourages original effort.

The vacancies are in the West of Scotland, on the Ayrshire Coast of the Firth of Clyde, an area that offers opportunity for golf, sailing and mountaineering.

The Company operates a five-day week, a Profit-Sharing Scheme and a Staff Pension Fund.

Assistance towards house purchase is available for married men who will also receive a refund of reasonable removal and travel expenses.

Brief personal details should accompany applications to :-

The Staff Manager,
IMPERIAL CHEMICAL INDUSTRIES LTD.,
Nobel Division,
460 Sauchiehall Street, Glasgow, C.2.

ICI

E7150 A

PLANNING MANAGER

Automatic Transmission Division

Applications are invited for this appointment with a new division of a prominent and substantial Manchester engineering group. The Planning Manager will be second in charge of the Division, and may be asked to take complete control in 5 to 7 years. Commencing salary will be between £1850 and £2250, plus pension scheme and other substantial benefits. Removal expenses will be paid.

The Planning Manager will be responsible to the Divisional Manager for evaluating the engineering content of design drawings, for establishing the production process and plant lay-out, and for the design and manufacture of jigs, tools fixtures and gauges. He will have the opportunity to establish the organisation of planning, time-study, plant engineering, jig and tool design and tool-room departments. His staff will number approximately 60 people, most of whom will not be appointed until the Planning Manager is established and can take his full part in the selection of his own subordinates.

Desired experience includes two or three years in a similar position in a flow or large batch gear cutting establishment, together with personal experience of jig and tool design, plant lay-out, work study and the specification of plant and equipment. A wide knowledge of modern engineering methods and management techniques are also necessary. A.M.I.Mech.E. or A.M.I.Prod.E. would be of advantage. Preferred age 35-50.

Please write briefly in first instance, quoting Reference No. 922, to :—

AA LYDC

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E7147 A

UNIVERSAL GRINDING WHEEL CO., LTD.,

require a

QUALIFIED ENGINEER

Aged 25–30 at their Stafford Works as Technical Assistant to a Factory Manager. Duties will include co-ordinating technical services associated with production, and assisting in the development of new methods and layout of a wide variety of plant.

Qualifications desired include H.N.C. and experience in production engineering.

Salary according to age and experience ; Staff Life Assurance and Pension Scheme.

Please write for application form, giving age and brief details of qualifications and experience to :

PERSONNEL MANAGER,
UNIVERSAL WORKS,
STAFFORD E7140 A

SITUATIONS WANTED

STRONG HEALTHY BOY, 18 years. Good family, pleasing manners. Keenly interested in mechanics and good driver, seeks suitable post in Garage. —Box 282, Smith's Library, Newton Abbot. E7120 B

GRADUATE ENGINEER, 32, ten years locomotive industry, drawing office and works, inland and abroad, present salary £1200 p.a., considers change.—BOX No. E3078, "The Engineer." B

BUSINESS OPPORTUNITIES

EXPORT GROUP will undertake export management for manufacturers wishing to enter or develop E.F.T.A. markets.—Please communicate with BOX No. E3079, "The Engineer." G

FOR HIRE

LATTICE STEEL ERECTION MASTS (light and heavy), 30ft. to 150ft. high, for immediate hire. —Bellman's, 38 Cornwall Gardens, London, S.W.7. Western 3033. E197 K

SUB-CONTRACTING

KELLERING AND CAM PROFILING capacity up to 8ft by 6ft or 6ft diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

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WANTED

By Public Engineering Company, for Cash or Shares.

A Company engaged in manufacturing Mechanical Handling Equipment. Nett assets required, approximately £300,000. Good profit record and capable of expansion. Present Management can remain.—BOX No. E3082, "The Engineer." L

PATENTS

THE PROPRIETOR of British Patent No. 756608, entitled "QUICK DETACHABLE PIPE COUPLERS" offers same for license or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern & Carlberg, 140, So. Dearborn Street, Chicago, 3, Illinois, U.S.A. E6964 H

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throughout the whole of the Engineering Industry
E194 RD

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BANKERS

(Gross assets £2,000,000), are paying 7½ per cent. p.a. interest on deposits for the seventh year in succession, with ¼ per cent. added annually on each £500 unit.—Details and Audited Balance Sheet from : Investment Dept. ER.

DAVIES INVESTMENTS LTD.,
DANES INN HOUSE, 265 STRAND,
LONDON, W.C.2.
E178 I

MACHINERY Etc. WANTED

WANTED FOR CASH all types of Electrical, Plant, A.C. & D.C. Motors, Diesel Generating Sets, Transformers, Turbo-Alternators, Cables Dismantling Staff Available.—ELECTRICAL PLANT & MACHINERY Co., 12 Hilton St., E.1. E5895 F

URGENTLY REQUIRED TO PURCHASE

All types of RECORD TOWER CRANES and 20-ton ELECTRIC DERRICK CRANES. Please forward full details.—BOX No. E7107, "The Engineer." F

FOR SALE

SALE BY TENDER

PECKETT STEAM LOCOMOTIVE—Saddle tank, 0-4-0, Serial No. 2010 (1941). Steam working pressure 170 lbs., standard gauge. In good condition. Various spare parts.

This may be inspected by arrangement with the Estate Manager, Industrial Estates Management Corporation for Wales, Hirwaun Industrial Estate, Aberdare, Glamorgan. (Tel.: Hirwaun 268.)

Further particulars and forms of Tender may be obtained from the Secretary, Estates Management Corporation for Wales, Treforest Industrial Estate, Pontypridd, Glamorgan. Tenders must be returned not later than 16th December, 1960. E7130

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Dish-ended, each 30ft. long by 8ft. diameter, 100 lbs. working pressure, with all fittings. Low Price.

G. E. SIMM (MACHINERY) LIMITED,
27, Broomgrove Road, SHEFFIELD, 10.
Tel.: SHEFFIELD 64436. E7134 G

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3-ton and 5-ton Overhead Travelling Cranes, hand-operated, suitable for power houses ; unused.

Dynamometer by Heenan & Froude, 50/700 h.p., 450/3500 r.p.m.

Further particulars willingly given.

FYFE WILSON & CO., Ltd., Stati on Works Bishop's Stortford. E192 G

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"CASWELL" 8-ton Erection-mast DERRICK CRANE. 75ft. Latticed mast with seven guy ropes. 63ft. Latticed Jib. Separate motorised hoist and Luffing drums, 400/3/50.—BOX No. E7111. "The Engineer." G

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'Phone Coleford 2271/5. E193G

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BESCO Size No. 612, All-Steel Folding Machine, working length 73in., capacity mild steel 12 S.W.G., clamping beam adjustable for round and sharp bends, with adjustable angle stop for repetition bending, weight approx. 2408 lb.

NEW BESCO No. 54, Type VM35/200, Multi-Purpose Punching Machine, motorised for 400/3/50 supply, max. punching pressure 35 tons, punches 1in. diameter through ¾in. plate, 2in. diameter through 3/16in. plate, vee notches angle iron 2in. by 5/16in., cuts flat bars up to 4in. by ¾in., rounds and squares up to 1in., weight approx. 2646 lb.

CRAIG & DONALD Deep Gap Guillotine Shearing Machine, motorised for 440/3/50 supply, with automatic hold-down and adjustable back gauge, capacity 14ft. by ¼in., complete with three spare sets of blades, weight approx. 11 tons.

BRADLEY & CRAVEN Motorised Geared Press Brake for 400/440/3/50 supply, max. pressure approx. 65 tons, forming capacity 10ft. by 12 S.W.G. or 8ft. by ¼in., length of bed and ram 120½in., width of bed 5in., weight approx. 8½ tons.

PRATT Power Operated Open Ended Guillotine Shearing Machine, motorised for 400/440/3/50 supply, capacity 6ft. by ¼in., with automatic hold-down and adjustable front, back and side gauges, weight approx. 58 cwt.

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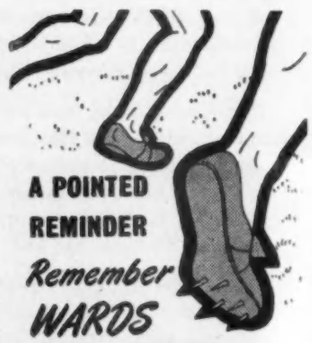
Telephone : Central 7606-8 E207 G



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AIR COMPRESSORS.—Two Bellias & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors ; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised ; and several other of various makes and capacities.
200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.
ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 200 h.p.
MOBILE ROAD CRANES.—10-ton Lorain lorry-mounted 30ft.-70ft. extendible jib ; 8¾-ton Ransome Diesel/Electric 21ft. jib ; 6-ton Coles Diesel/Electric, solids ; 4-ton Coles Diesel/Electric, solids, 1945 ; 3-ton Jones "Super 40" diesel, pneumatics (3).
OVERHEAD CRANES.—25-ton Girders and end carriages, with 60 h.p. motors, 95ft. 10in. span ; 30-ton Vaughan, 42ft. 3in. span ; 25-ton Clyde, 21ft. 9in. span, new 1954 ; 20-ton Vaughan, 42ft. 3in. span, 6-ton auxiliary, cab control (5) ; 20-ton King, 42ft. 3in. span, 400/3/50 ; 10-ton Heywood, 34ft. span, new 1933, (2) ; 10-ton Morris, 32ft. 10in. span, 400/3/50 ; two 10-ton, 60ft. span, 1955 ; two 7-ton, 37ft. span, 1950 ; Wharton, 7½-ton, 25ft. span, 400/3/50 ; 5-ton, 37ft. span, 1944 ; 5-ton Henderson, 24ft. 7in. span, 1946 ; 5-ton King, 29ft. 3in. span, power hoist, hand travel ; 5-ton Morris, 28ft. 6in. span, power hoist, hand travel ; 4-ton Morris. 19ft. span, 220V. d.c. (3) ; majority of the above are unused.
DERRICK CRANES.—7-ton Anderson Grice, 100ft. jib, electric ; 1½-ton Anderson Grice, hand, 40ft. jib ; 5-ton Butters Grabbing, 80ft. jib, electric.
RAIL CRANES.—18-ton Brownhoist, steam, 50ft. jig ; 10-ton Grafton, 34ft. jib, diesel conversion ; 8-ton Wilson, steam, 35ft. jib ; 5-ton Smith, 50ft. jib (2).
LOCOS.—Fowler diesel, 150 h.p. (2) ; Barclay & Ruston, 80/88 h.p., diesel ; Bagnall 14in. by 22in. (two oil-fired, one coal), Peckett, steam, 7in. by 12in., 1941 ; 4 Logan Battery-operated, 24in. gauge, 3-4-ton cap. ; 3 Ruston diesel 16/20 h.p., 24in. gauge ; also 2 miles 20 lb. and 1200 yds. of 25 lb. x 24in. gauges track, Bogies, Wagons, &c.
STEELPIPING.—Large stocks including following : 20,000ft. 1¼in. galvanised "A" ; 20,000ft. scaffolding ; 30,000ft. 3in. black ; 15,000ft., each 6in., 3/16in., ¼in., 5/16in., unused ; 5000ft., 8in. unused ; 2000ft., 10in., 12in., 16in., seamless ; 200ft., 24in. by ¼in. welded, unused ; 1000ft., 30in. by ¼in. welded, unused ; 2500ft., 27in. welded flanged ; 500ft., 36in., unused ; 500ft., 42in. by ¼in. riveted ; 100ft., 48in. by ¼in. welded unused ; 150ft., 60in. welded ; 20in., 24in., 26in., 27in., 28in., bitumen lined, unused. Full list on request.
CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s., including 150 by 18ft. lengths, 6in. Stanton class "B" Spigot and Socket, unused. Immediate delivery.
VALVES.—Exceptional Surplus Ministry Lot. New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock all sizes, Parallel Slide Sluices, Gunmetal, Reducing and Check Valves. List on request.
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AUTOCLAVES.—Two 26ft. by 9ft. dia. hinged doors ; new 1948, about 45 lbs. working pressure ; jacketted autoclave, 12ft. by 7ft. diameter, bolted lid, approx. 60 lbs. steam pressure.

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By Order of the Secretary of State for War

GOVERNMENT SURPLUS STORES

SALES BY AUCTION

		Main Location	*Auctioneers*
November 22	Vehicles, etc.	Command Vehicle Park, Long Kesh Aerodrome, Hillsborough, Co. Down.	OSBORNE KING & MEGRAN (Dept. L), 14, Montgomery Street, Belfast. (Tel.: 30433.)
November 24-25	Vehicles and miscellaneous stores.	W.D. Storage Depot, Bowhouse, Hurlford, Nr. Kilmarnock, Ayrshire.	DIXON & WALLACE LTD (Dept. L), Bank Buildings, Graham Square, Glasgow, E.1. (Tel.: Bridgeton 2447/9.)
November 29-December 1	Vehicles, earth moving equipment, mobile cranes and motor cycles.	W.D. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)

Approximately 1800 items of earth moving, road making and lifting plant ; vehicles ; trailers ; motor cycles ; plant spares, &c., including : excavators by Priestman ("Wolf") ; Ruston Bucyrus ("10RB" & "19RB") ; Wayne ("Model 40") ; crawler tractors ; angledozers and bulldozers by Caterpillar ("D7's" and "D8's") ; mobile cranes by Coles ; Cranemobile ; Hyster ; Morris (some diesel and/or lorry mounted) dumpers ; Chaseside shovels ; road rollers by Aveling Barford and Wallis Stevens ; Fork-lift trucks by Coventry Climax (diesel) and Ross ; trailer-mounted fire pumps ; snow ploughs ; diesel air compressor by Broomwade ; (trailer-mounted) mobile welding and generating sets ; wheeled tractors (some with low-loading plant trailers) by A.E.C. ; Diamond "T" and Mack ; mobile talkers ; (self-propelled and trailer-mounted) 100 to 2500 gallons capacity ; 220 saloons, limousines and estate cars (including Rolls Royce 7-seater limousine and 67 Ford "Anglias," "Populars," and Morris "Minors") ; 59 Land Rovers, utilities, tippers, coaches, trucks of all carrying capacities (many fitted with diesel engines) ; trailers—10 cwts. to 10 tons ; plant ancillaries and spares by Caterpillar, Hyster, International, Le Tourneau, Ruston Bucyrus, Waynes, &c. ; lead/acid vehicle batteries ; 560 solo and combination motor cycles by B.S.A., James, Matchless, Norton and Triumph.

December 13	Machine tools and miscellaneous stores.	W.D. Storage Depot, Byley, Nr. Middlewich, Cheshire. (Sale at Cheetham Town Hall, Manchester, 8.)	J. H. NORRIS & SON (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)
1961 January 4	Miscellaneous stores.	Northern Command Ordnance Sub. Depot, Barlow, Nr. Selby, Yorks.	BARTLE & SON (Dept. L), 50-52, Merrion Street, Leeds, 2. (Tel.: 20898.)
January 11	Machine tools and miscellaneous stores.	Central Ordnance Depot, Tidworth. Central Ordnance Sub-Depot, Devizes. (Sale at Corn Exchange, Devizes.)	FARRANT, WIGHTMAN & PINNIGER (Dept. L), Market House, 2, Newport Street, Swindon. (Tel. : Swindon 5151-2.)
January 19	Miscellaneous stores.	W.D. Storage Depot, Rotherwas, Hereford.	RUSSELL, BALDWIN & BRIGHT, LTD. (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)
January 27	Miscellaneous stores.	Command Ordnance Depot, Coypool, Marsh Mills, Plymouth. (Sale at Kinterbury House.)	WOOLLAND SON & MANICO (Dept. L), Kinterbury House, St. Andrews Cross, Plymouth. (Tel.: 69292.)

Application for catalogues, available 14 days prior to date of sale should be made only to the auctioneers shown above (price of catalogue 1s.—P.O. only). W.O. Disposals 1 (a), First Avenue House, High Holborn, London, W.C.1. CHAncery 6888, Ext. 1301. E118 j

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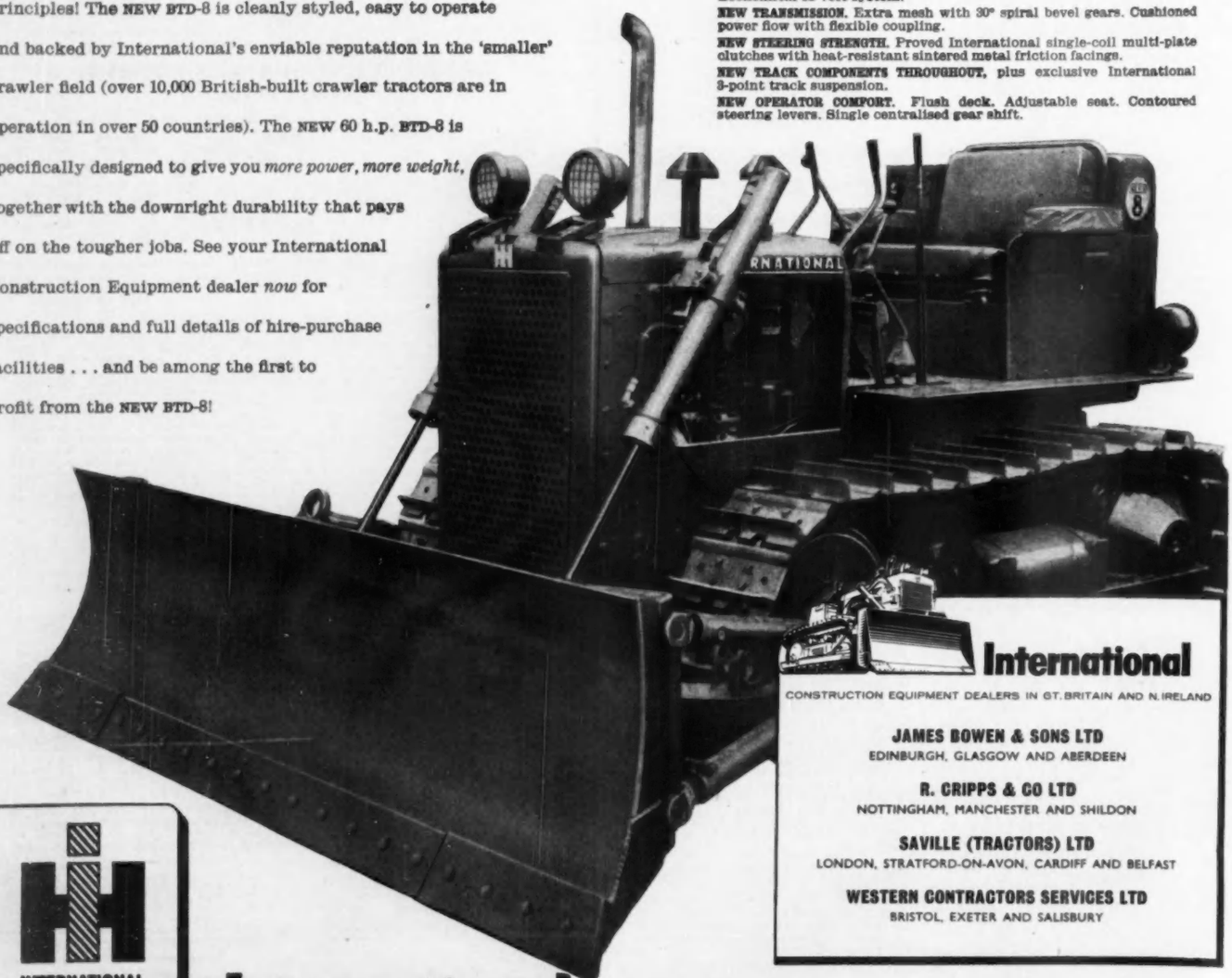

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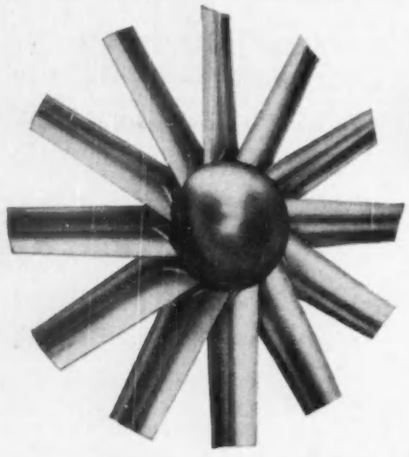

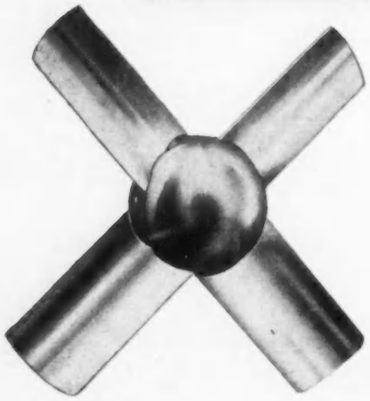

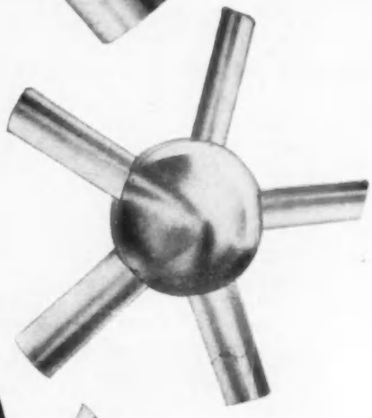

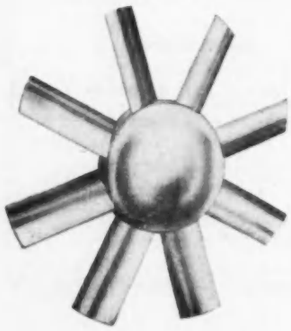

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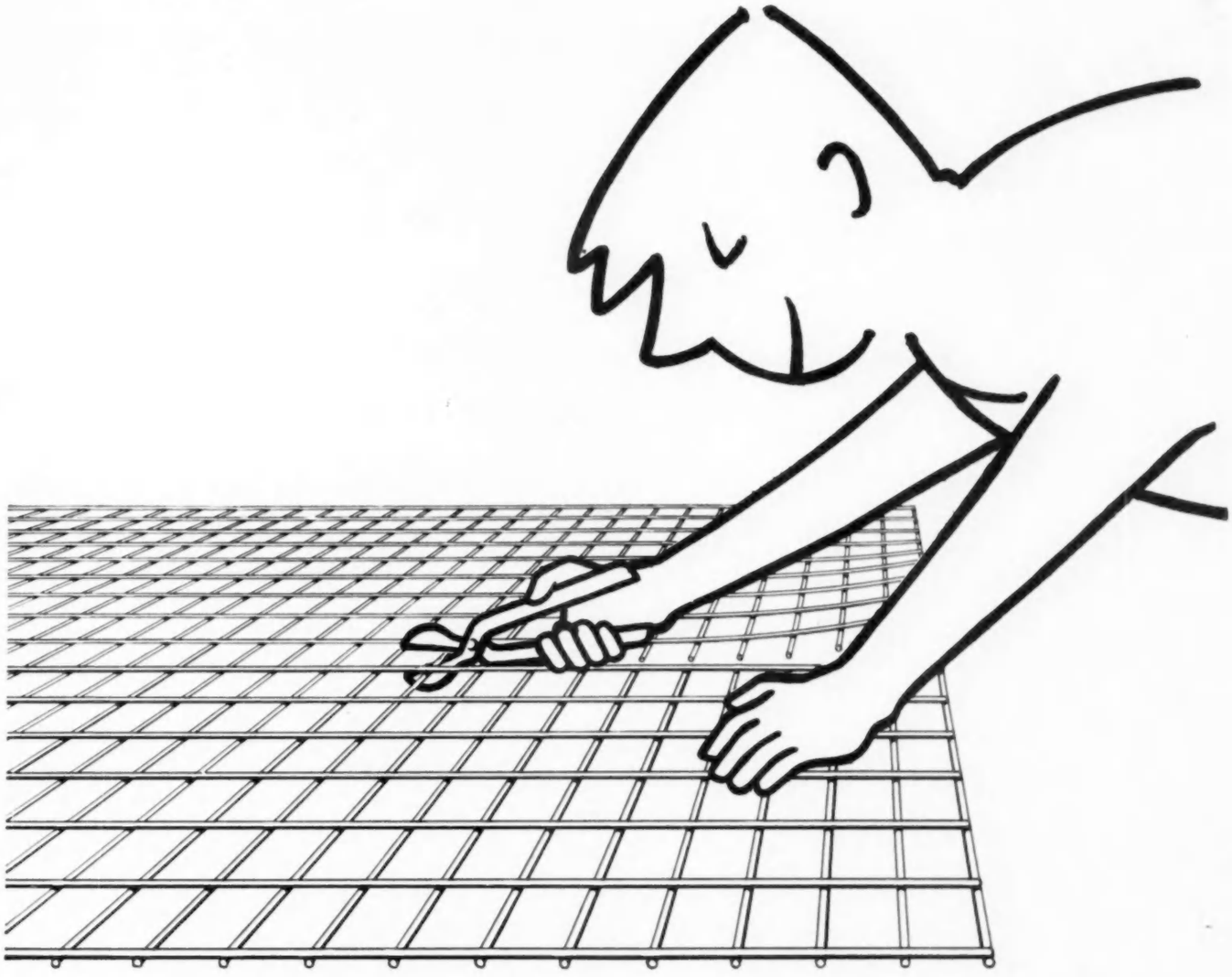

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